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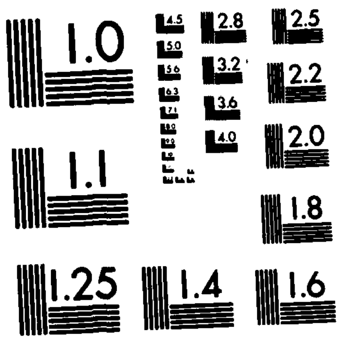

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A COMPILATION OF MOORED INSTRUMENT DATA AND ASSOCIATED OCEANOGRAPHIC OBSERVATIONS, VOLUME XXX (GULF STREAM EXTENSION AND NORWEGIAN SEA OVERFLOW INTRUSION EXPERIMENTS) 1979 - 1980

by

Ellen Levy, Susan A. Tarbell
and
N. P. Fofonoff

October 1982

TECHNICAL REPORT

Prepared for the Office of Naval Research, Ocean Science and Technology Division under Contract N00014-76-C-0197; NR 083-400.

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The measurements were made as part of two concurrent experiments, the Gulf Stream Extension (GSE) and the Norwegian Sea Overflow Intrusion (NSOI) arrays. Data from the current meters are presented in statistical tables and graphically as scatter plots, histograms, progressive vector plots, spectral plots and time series plots. Filtered time series are shown in composite displays. Data from XBT, CTD and T/Ps are also presented graphically.

WHOI-82-43

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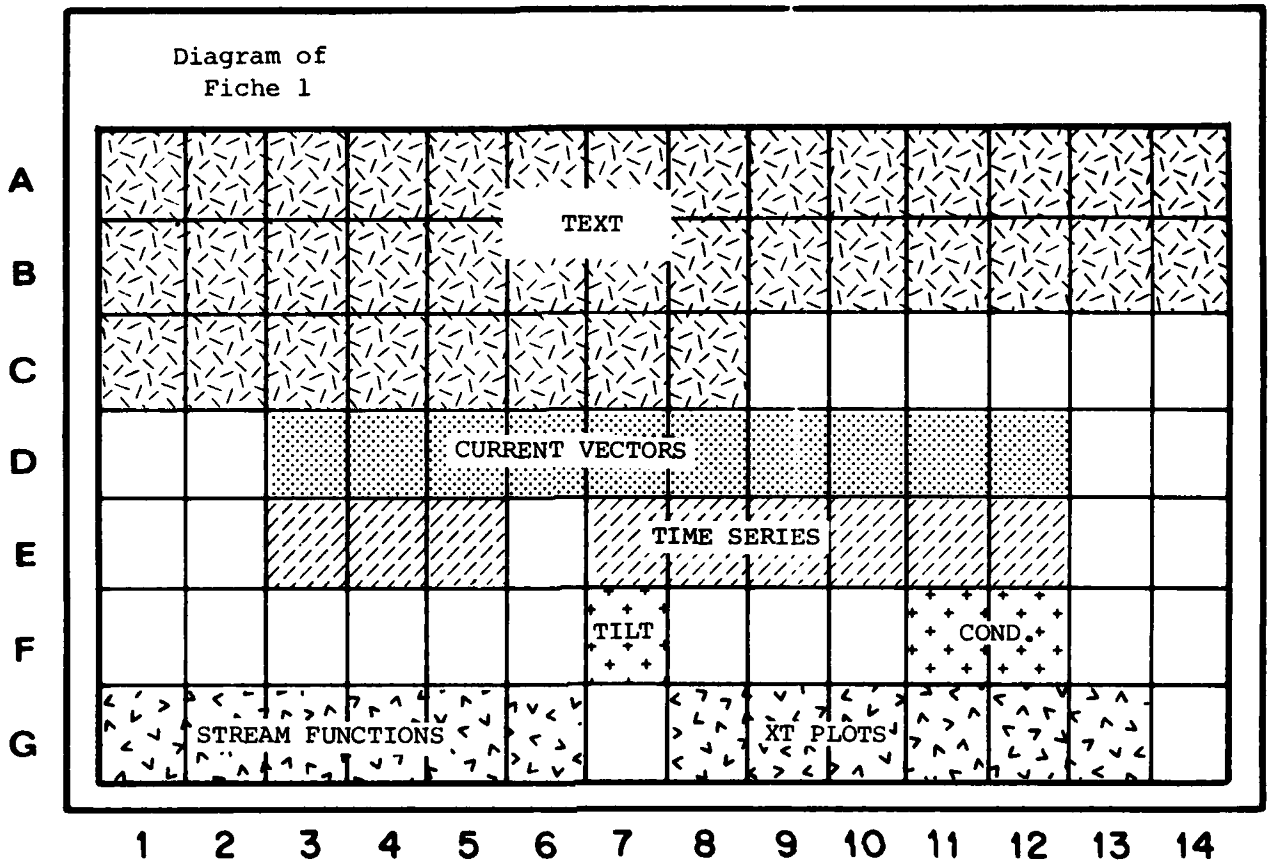
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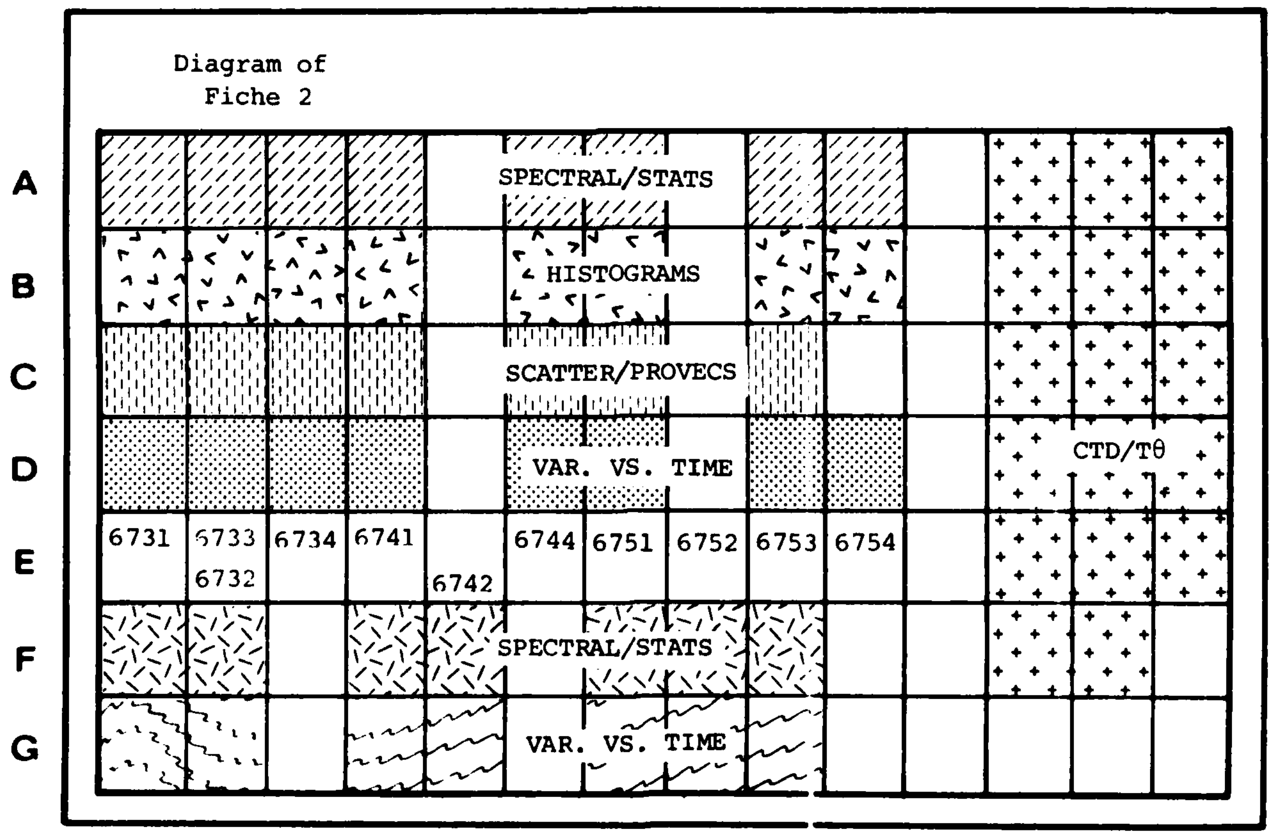
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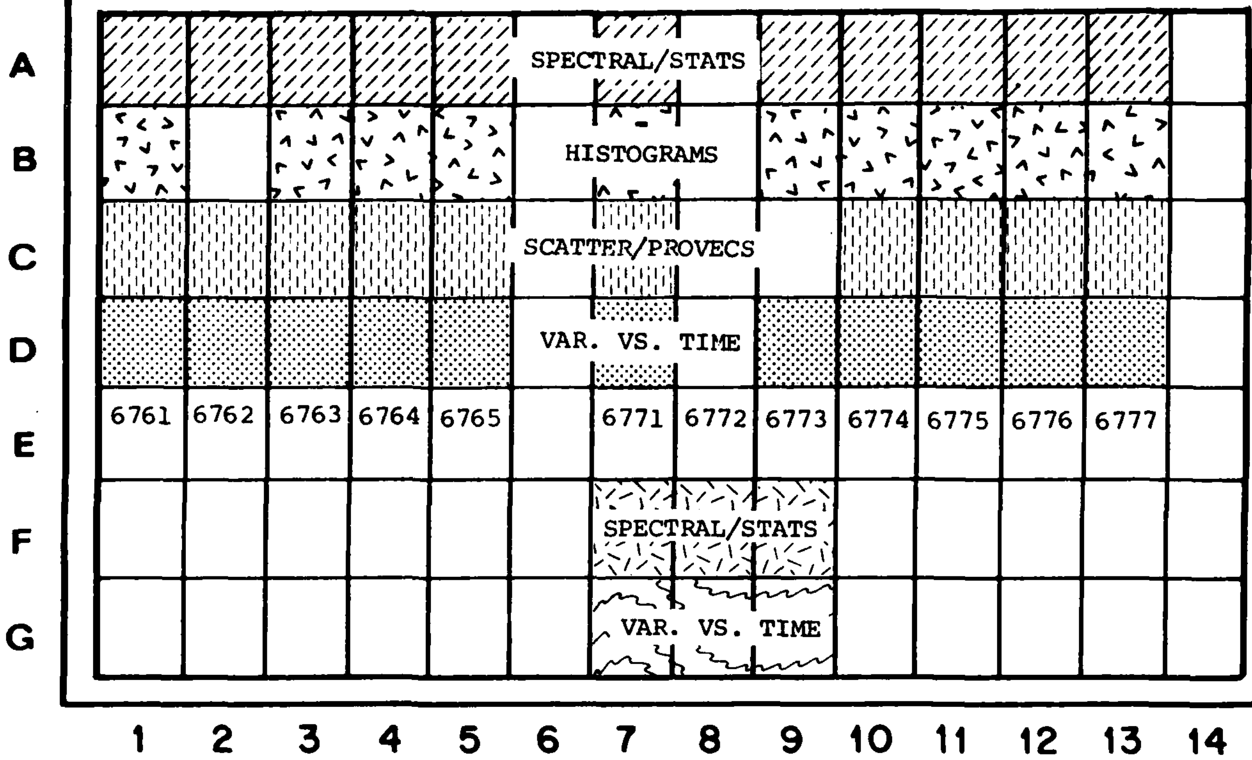

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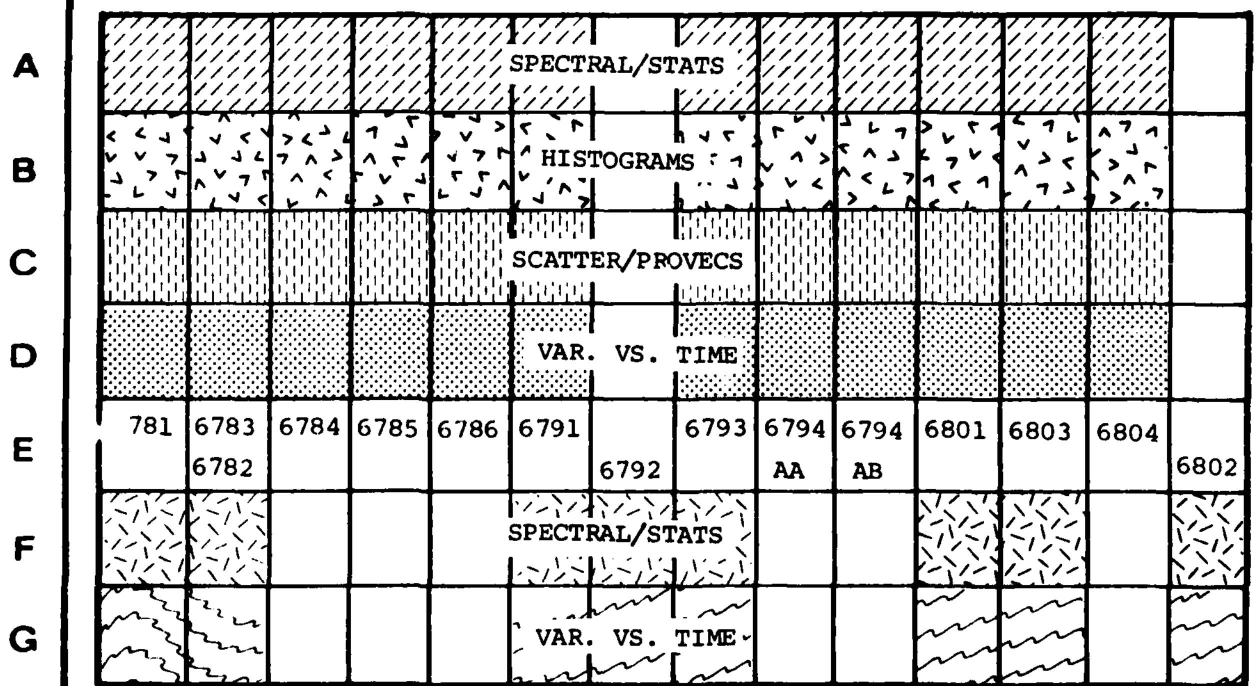

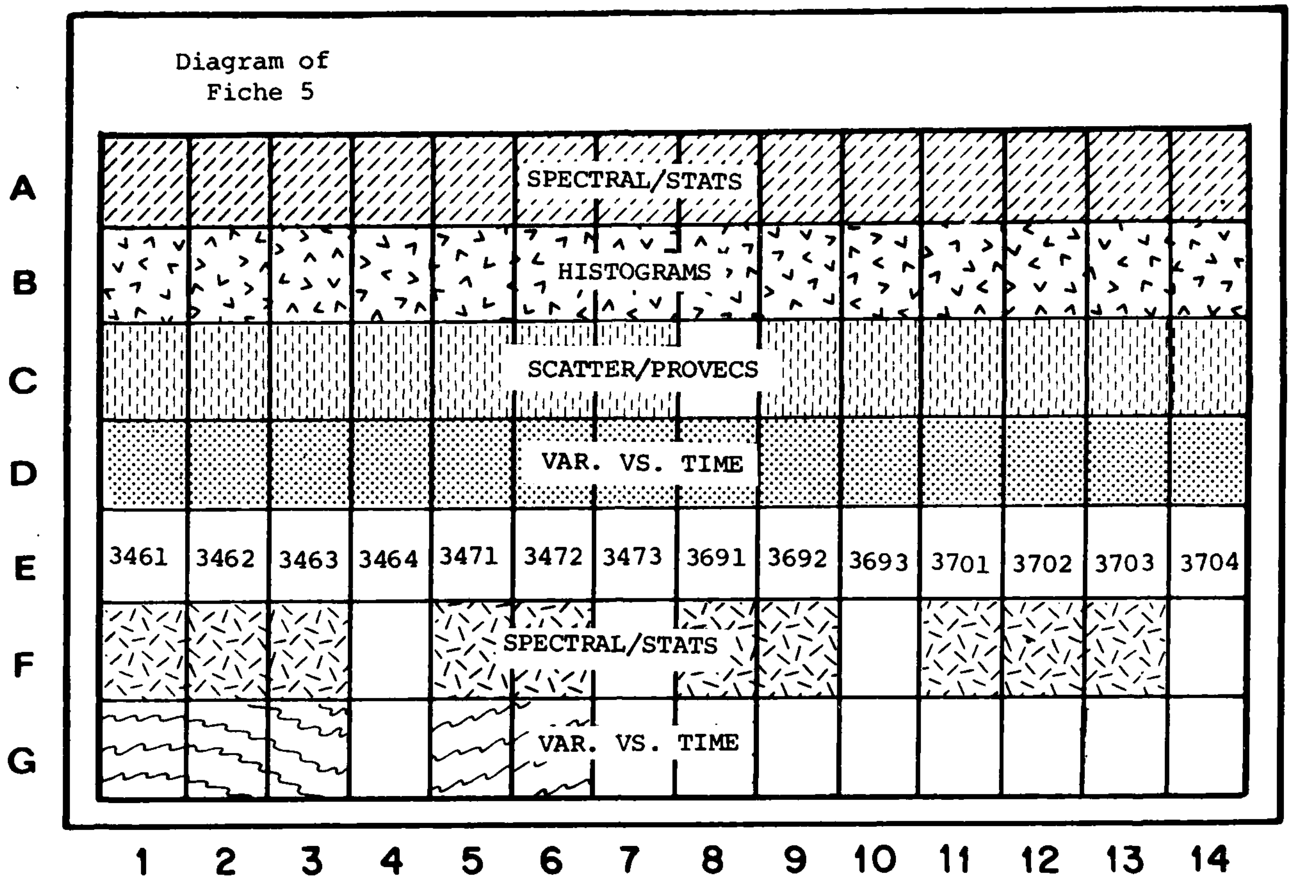
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Many people should share the credit for the success of the experiments. They include the people in the Buoy Group instrument shop, those who worked on mooring hardware and design, and the officers and crew of the R/V KNORR. Nick Fofonoff (WHOI), Ross Hendry from the Bedford Institute of Oceanography (BIO) and Paul Laviolette from Naval Ocean Research and Development Activity (NORDA) were the principal investigators of the Gulf Stream experiment. Larry Armi, presently at Scripps, investigated the Norwegian Sea Overflow Intrusion. Gordon Volkmann (WHOI) prepared the XBT plots. The BIO data is included in this report with the permission of Ross Hendry. We appreciate the help of W. Brechner Owens and Bach-Lien Hua for their help on the streamfunction maps.

The experiment was supported by the Ocean Science and Technology Division of the Office of Naval Research (Contract #N00014-76-C-0197; NR 083-400).

PREFACE

This volume is the thirtieth in a series of Data Reports presenting moored current meter and associated data collected by the WHOI Buoy Group.

Volumes I-VII present data prior to 1969 and are not listed below.

Volumes VIII through XXIX present data obtained during the years 1969-1979, arranged either by year or experiment (see notes).

A data directory and bibliography for the years 1963-1978 has been published, as WHOI Technical Report 79-88.

Volume XXX presents data from the Gulf Stream Extension and Norwegian Sea Overflow Experiments, 1979-1980.

Volume No.	WHOI Ref. No.		Notes Year Experiment
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X	76-40	Tarbell, S.	1969a measurements
XI	76-41	Tarbell, S.	1969b measurements
XII	76-101	Chausse, D. and S. Tarbell	1973 MODE Array
XIII	77-18	Tarbell, S. and A. W. Whitlatch	1970 Measurements
XIV	77-41	Tarbell, S., R. Payne and R. Walden	1976 mooring 592 Saint Croix
XV	77-56	Tarbell, S. and A. W. Whitlatch	1971 measurements
XVI	78-5	Tarbell, S. and A. Spencer	1971-1975 MODE Site
XVII	78-49	Tarbell, S., A. Spencer and R. E. Payne	1975-1977 POLYMODE Array II
XVIII	79-65	Tarbell, S., M. G. Briscoe and R. A. Weller	1978 JASIN
XIX	79-34	Spencer, A., C. Mills and R. Payne	1974-1975 POLYMODE Array I
XX	79-56	Spencer, A.	1974 Rise Array
XXI	79-85	Mills, C. and P. Rhines.	1978 W.B.U.C.
XXII	79-87	Tarbell, S. and R. Payne.	1973 measurements
XXIII	80-40	Tarbell, S. and R. Payne.	1978 POLYMODE Array III
XXIV	80-41	Spencer, A. , K. O'Neill and J. R. Luyten	1976 INDEX
XXV	81-12	Spencer, A., E. D'Asaro and L. Armi	1977 B.B.L. Expt.
XXVI	81-45	Chausse, D. and R. Payne	1972 measurements
XXVII	81-68	McKee, T., E. Francis and N. Hogg	1975,78 topographic expts.
XXVIII	81-73	Mills, C., S. Tarbell, W. B. Owens and R. Payne	1978 L.D.E.
XXIX	82-16	Levy, E., A. Spencer, G. Needell, G. Hund, and J. R. Luyten	1979 INDEX

PRESENTATION

The printed portion of the report contains introductory text and information about the instruments and data processing procedures. Tables and figures give information on moorings, instruments and the quality of the data. Data are shown graphically in numerous composite displays.

These pages are also reproduced on microfiche (fiche) one. Fiche two, three and four contain standard displays of data from each individual instrument on the WHOI moorings and data from CTD stations in the array area. Fiche five contains displays of the basic current meter data from the Bedford Institute moorings. Included in these displays are spectral plots, tables of statistics, time series, histograms, progressive vector diagrams and scatter plots.

A detailed layout of the microfiche is shown on pages iii through v. Each printed page is numbered at the top, with a fiche designation at the bottom.

INTRODUCTION

The Gulf Stream Extension (GSE) Array experiment explored the eddy kinetic energy (EKE) distribution and mean flow eastward of POLYMODE Array II, extending to the Mid-Atlantic Ridge. Two moorings deployed east of the Southeast Newfoundland Ridge by the Bedford Institute of Oceanography (BIO) augmented the array.

The Norwegian Sea Overflow Intrusion (NSOI) experiment was concurrent with the GSE experiment. This experiment explored the strength and temperature variability of Denmark Straits Norwegian Sea Overflow Water where it becomes part of the deep water of the North Atlantic. The NSOI instruments were placed low on two of the GSE moorings (677 and 678) as well as on one additional mooring (676). For economical purposes, the GSE and NSOI moorings were shared.

Eight WHOI moorings, with a total of thirty-three current meters, of various types and seven temperature-pressure (T/P) recorders, were set during October and November of 1979 and recovered in November of 1980. These moorings support the Gulf Stream experiment instruments as well as the Norwegian Sea Overflow experiment instruments. Two Bedford Institute of Oceanography moorings with a total of eight current meters were set in September of 1979, picked up in April of 1980, reset in May 1980 and recovered in September of 1980. The data from these BIO moorings were examined in conjunction with the WHOI data from the Gulf Stream experiment.

See Figures 1 and 2 for details of instrument locations.

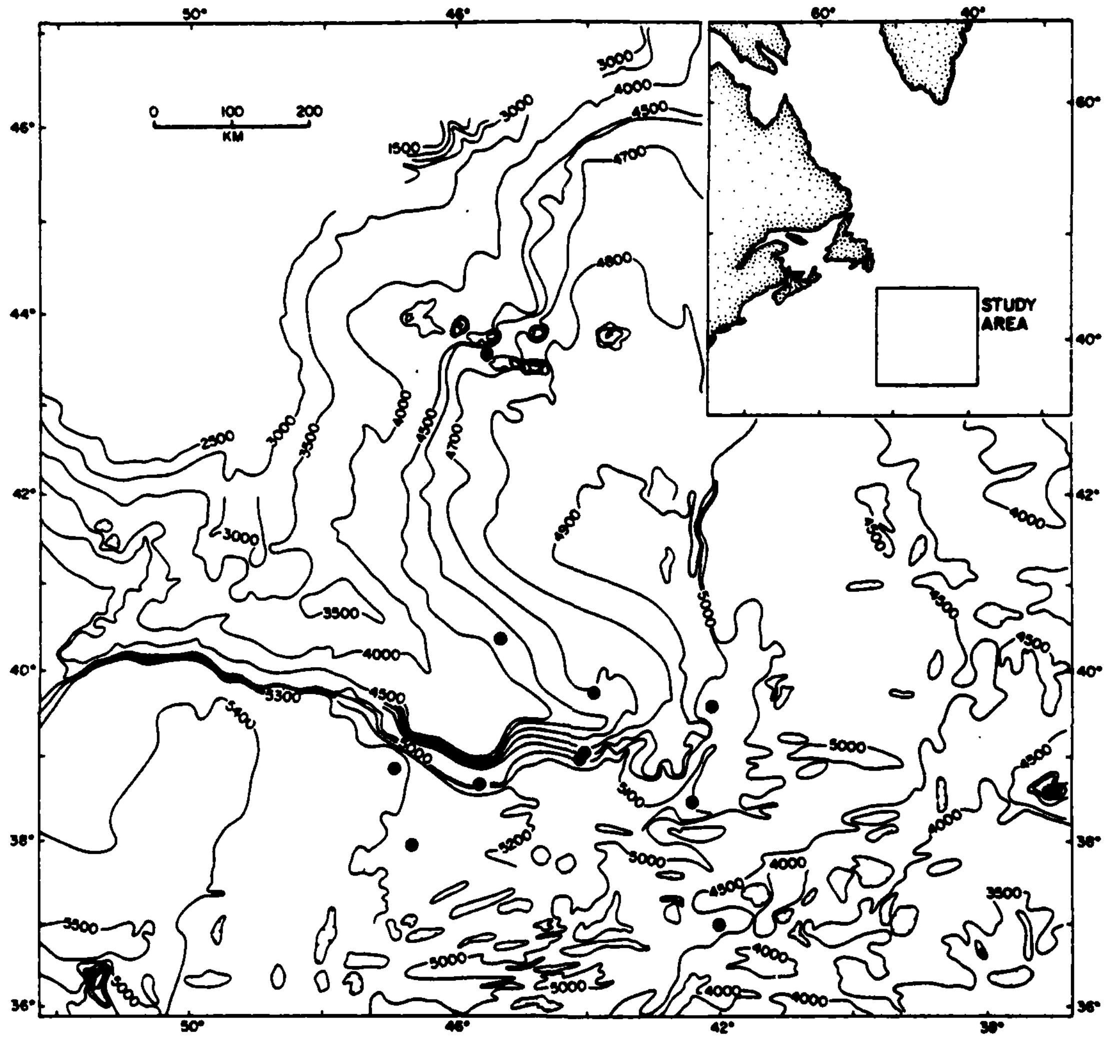


Figure 1: Array configurations of both WHOI and BIO moorings relative to bottom topography of the Southeast Newfoundland Ridge.

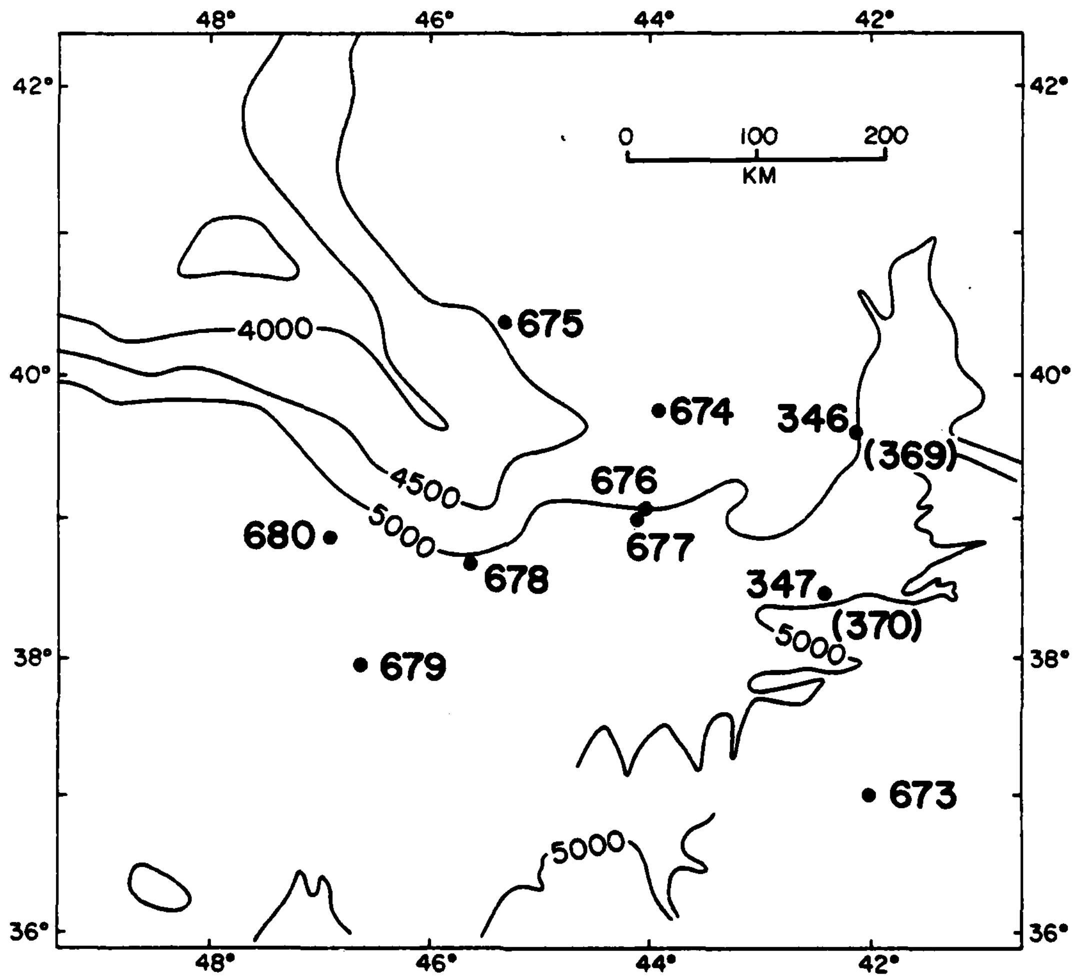


Figure 2: Total mooring array of GSE and NSOI experiments including WHOI and BIO moorings. Individual moorings are labeled.

INSTRUMENTATION

Current Meters

The current meters used in these experiments were of four basic types: model 850s, vector averaging current meters (VACMs) , acoustic current meters (ACMs) and Aanderaa model 5 recording current meters (RCM5s).

The Model 850 current meters were built by Geodyne, now a part of Egerton, Germeshausen, and Greer (EG&G). They store burst sampled data on magnetic tape cartridges, collecting 7 data cycles at 5.27 second intervals, and then turn off for the remainder of the recording interval. Model 850s accumulate the count from the temperature circuit from one 5.19 second period and store it at the beginning of each data burst.

On WHOI instruments, time was measured using a quartz crystal oscillator with a manufacturer's specified accuracy of ± 1 second per day. All stated times are specified in UTC (Universel Temps Coordonné). The instrument clock times were synchronized with UTC before the mooring launch, and after the recovery the differences in the two times were noted.

VACMs are built by AMF Sealink Systems (now EG&G Sealink Systems). Each time a pair of rotor magnets passes the sensing diode, the VACM samples compass and vane information and computes a measure of east and north current components. These components are summed through the entire recording interval, usually 15 minutes, giving a true vector average. Temperature is derived from a voltage-to-frequency converter (v/f), whose output frequency is related to the thermistor resistance at its input. The v/f output pulses are summed over the entire recording interval, averaging temperature. The thermistors are routinely calibrated before and after deployment and the temperatures are accurate to ± 0.01°C (Payne et al., 1976). All variables are recorded on a cassette tape at the end of each recording interval. Some of the VACMs were modified to include

data from thermistor chains. These were used in the Norwegian Sea Overflow experiment. Inclination was measured and recorded in a modified VACM on mooring 677 througout the sampling period (see Figure 27).

Two Neil Brown Instrument Systems, Inc. acoustic current meters (NBIS-ACMs) were set on NSOI moorings as an in-situ test. These instruments operate in a burst mode, consisting of 180 contiguous ten second samples for one-half hour out of each six hours (e.g., four bursts per day). This form of data sampling is intended to observe higher frequency processes than those observed by the VACMs located on the same moorings. The test data recorded from these instruments are not included in this report.

The instruments used on the two BIO moorings were recording current meters (RCM5s), built by Aanderaa Instruments of Norway. Data are recorded internally on 1/4 inch reel to reel magnetic tape. A quartz clock triggers each measuring cycle. All the instruments measured horizontal current velocity and temperature. The RCM5s at 500, 800 and 1500 meter depths also measured pressure and electrical conductivity, allowing the monitoring of mooring motion and the derivation of salinity (see Figures 28 and 29). CTD measurements were used to calibrate all but the 800 and 1500 meter instruments on the first deployment. The 4000 meter instruments were modified to allow at least 0.008°C temperature resolution.

Temperature/Pressure Recorder

An instrument to record temperature, pressure and time (T/P) was developed in the Draper Laboratory at MIT for MODE-1 and has been used extensively since 1973. The instrument stores a sample every 15 seconds and records the sum of 128 successive data samples every 32 minutes on a magnetic tape cassette (128 x 15 = 1920 seconds = 32 minutes).

Temperatures have a resolution of 0.001°C (Wunsch and Dahlen, 1974). The absolute accuracy is not specified.

The pressure sensor is a strain gauge with a manufacturer-specified accuracy of 0.03 per cent of full scale (Wunsch and Dahlen, 1974). These sensors are recalibrated for each instrument deployment.

XBT

XBT (750-meter) probes were used to measure water temperatures on both the set and retrieval cruises. Measurements were taken about every two hours along the ship's track and about every hour around the moorings. Surface bucket temperature measurements were taken at each XBT location on both cruises. On the KNORR 75 set cruise a complete dual recorder-launcher system was installed with a cross over switch and calibration box. Two separate XBT systems without the cross connection switching arrangement were used on the KNORR 85 retrieval cruise, and the red canister technique was used for calibration rather than the newer calibration box.

The ATLANTIS II 107 Leg I preceded the KNORR 75 cruise by about two days and followed a course 50 to 100 miles north. XBT thermal profiles from the KNORR 75 and KNORR 85 cruises as well as a composite profile from the KNORR 75 and the ATLANTIS II cruise can be seen in Figures 3, 4 and 5.

CTD

A Neil Brown Instrument Systems, Inc. CTD (Brown, 1975) was used to help locate mooring sites 676, 677, and 678. This instrument obtains vertical profiles of conductivity, temperature and pressure. Table 1 presents the CTD stations in the mooring array area with dates, latitudes, and longitudes. Plots of potential temperature, salinity and oxygen versus pressure and potential temperature versus salinity (θ-S) diagrams are included on fiche two for each mooring site, and a sample is shown in Figure 6.

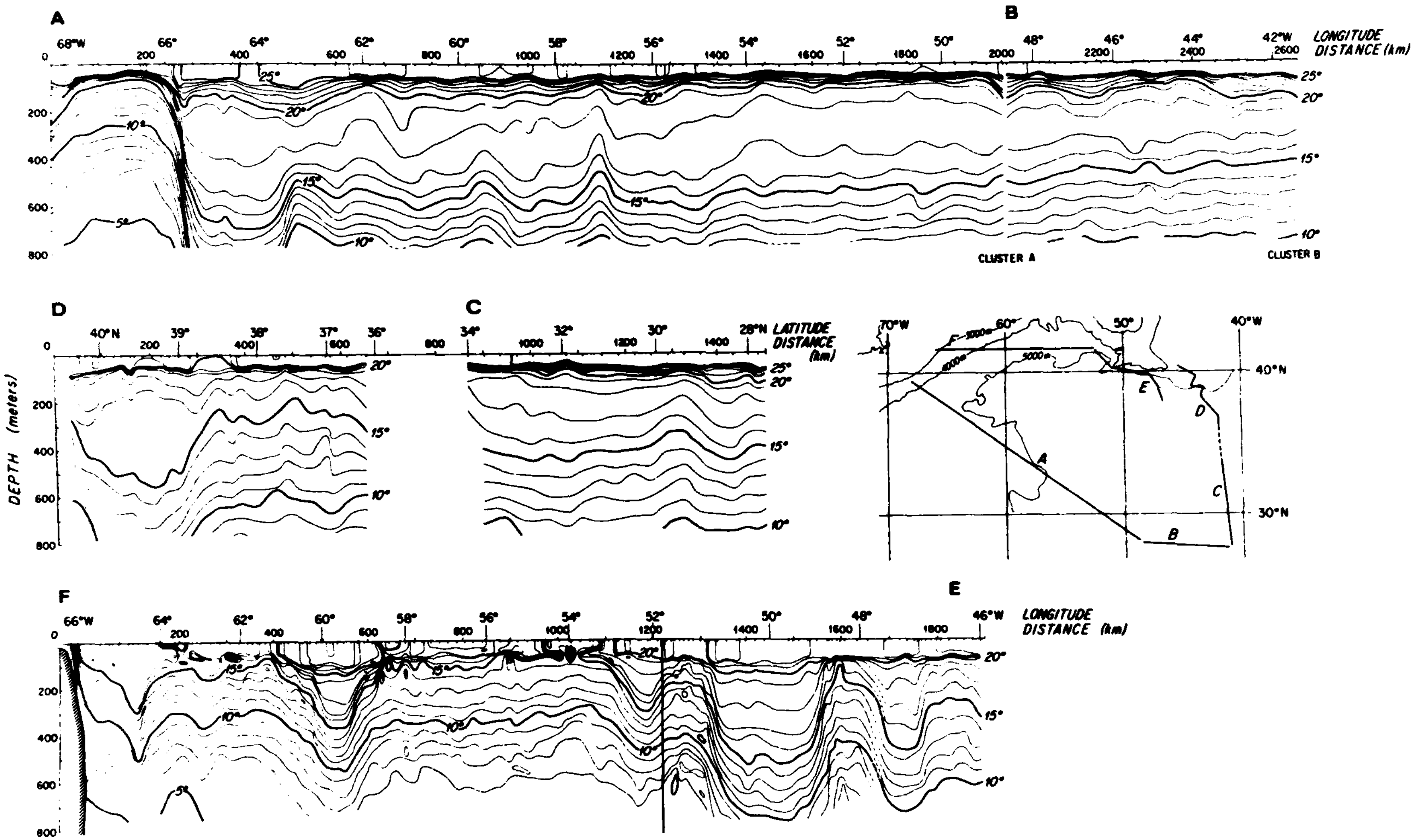


Figure 3: KNORR Cruise 75 XBT sections, October - November 1979. The inset map shows the location of the sections. Strong thermal features with weak surface expressions were found in the area of the mooring array (Sections D and E).

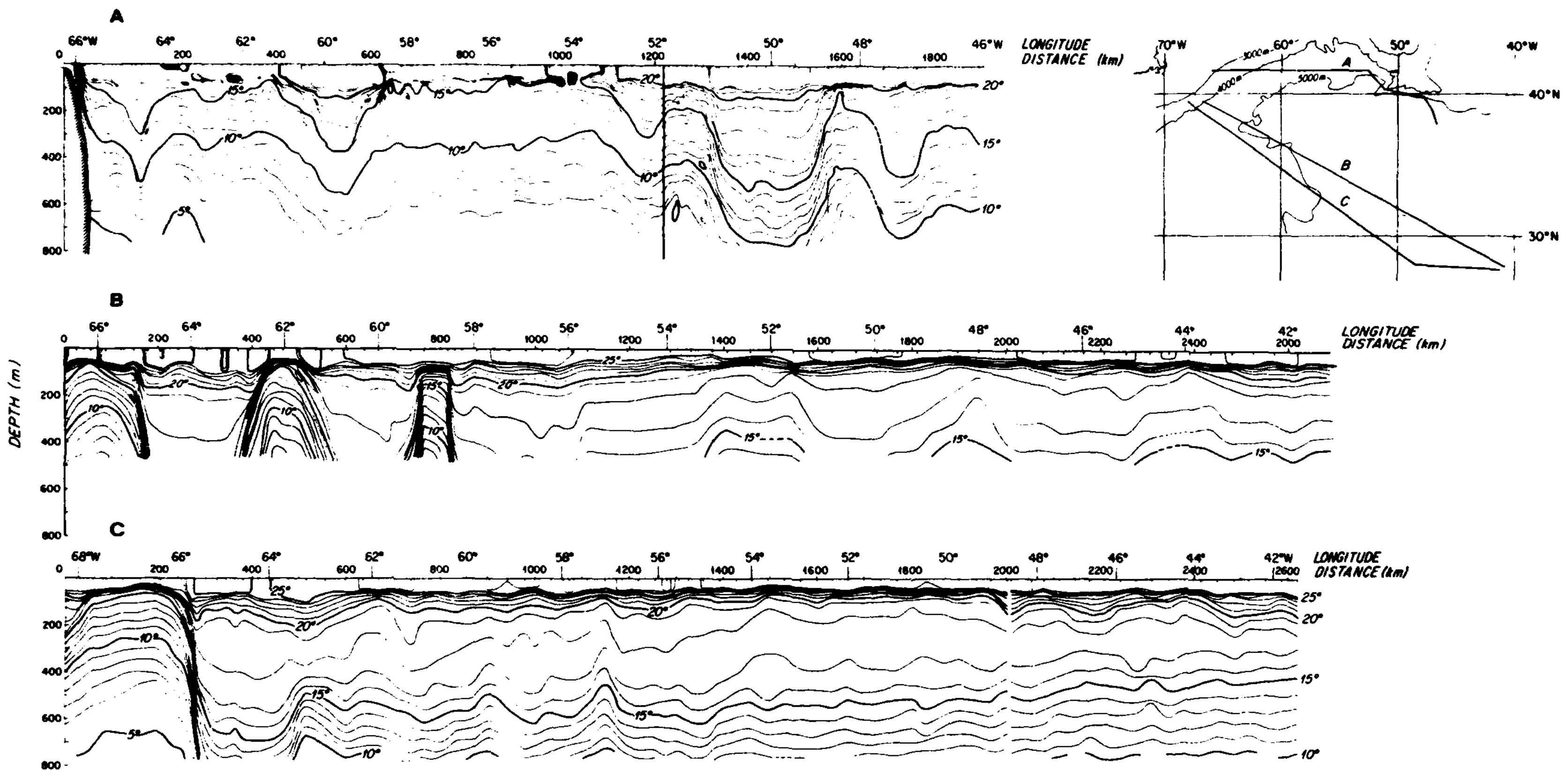


Figure 4: Composite plot of two KNORR Cruise 75 sections, A and C, and ATLANTIS II Cruise 107 Leg I (section B). Inset map shows course location of AII slightly north of KNORR 75 C section. There is considerably less structure along this C section than the AII section.

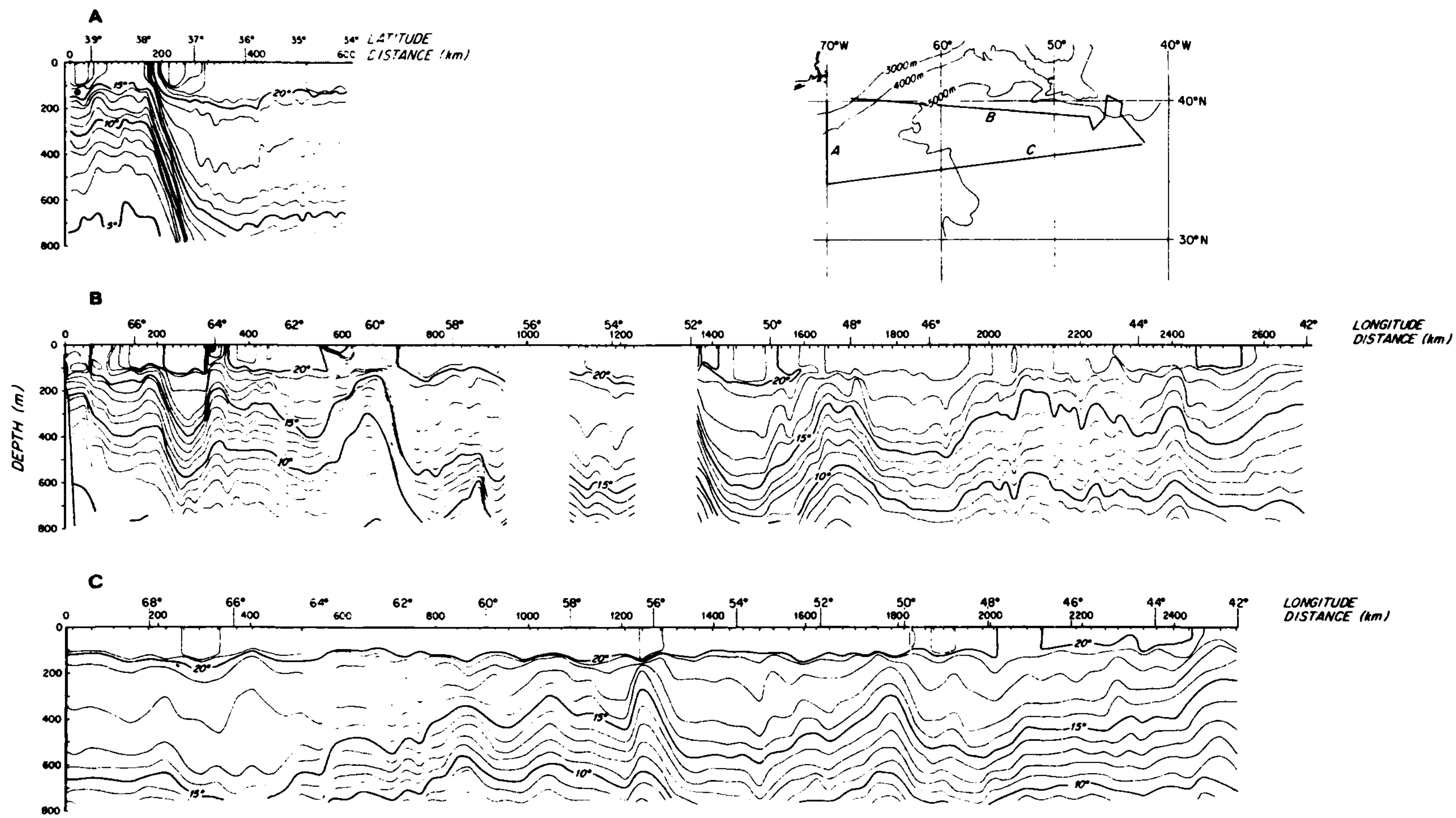
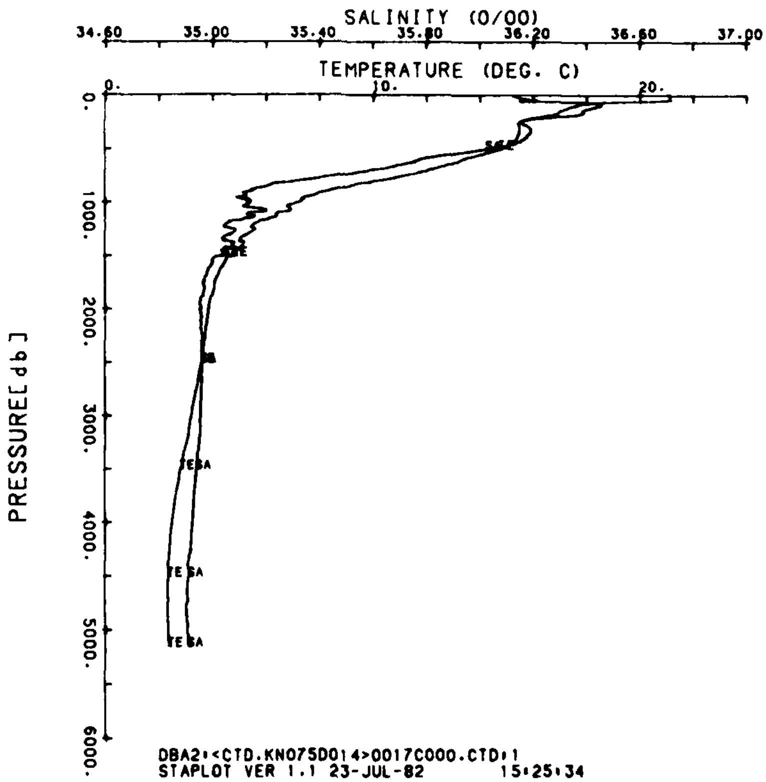


Figure 5: KNORR Cruise 85 XBT sections, November-December 1980. The inset map shows the location of the sections. Gaps are due to rough weather. There is considerable variability starting with eddy near 50°W of section B. A pronounced rise of about 200 m in the isotherms for the region from 64°W to 56°W with a steep rise at both ends sharp enough to be called fronts.

CTD LOCATIONS

CTD Station	Date	Time	Latitude	Longitude
3	18-X-79	1508Z	27 52.20 N	48 40.40 W
4	20-X-79	1029Z	27 25.30 N	41 10.00 W
6	23-X-79	1139Z	36 59.00 N	42 00.50 W
7	24-X-79	42Z	38 12.30 N	43 19.00 W
8	24-X-79	532Z	38 21.00 N	43 18.00 W
9	24-X-79	1225Z	38 35.50 N	43 18.00 W
10	24-X-79	1723Z	38 49.00 N	43 13.00 W
11	25-X-79	531Z	38 59.30 N	44 1.70 W
12	28-X-79	349Z	39 9.40 N	44 00.70 W
13	28-X-79	1100Z	39 16.50 N	44 00.30 W
14	28-X-79	1653Z	39 2.50 N	44 1.20 W
15	29-X-79	855Z	39 9.90 N	44 00.70 W
16	30-X-79	641Z	39 00.00 N	44 4.00 W
17	30-X-79	2140Z	38 37.00 N	45 29.30 W
18	31-X-79	936Z	38 27.67 N	45 30.48 W
19	1-XI-79	448Z	37 59.80 N	46 39.80 W
20	3-XI-79	147Z	40 11.70 N	49 51.40 W

Table 1: KNORR Cruise 75 CTD stations, October-November 1979. The table shows time and location of each station.



STATION 17

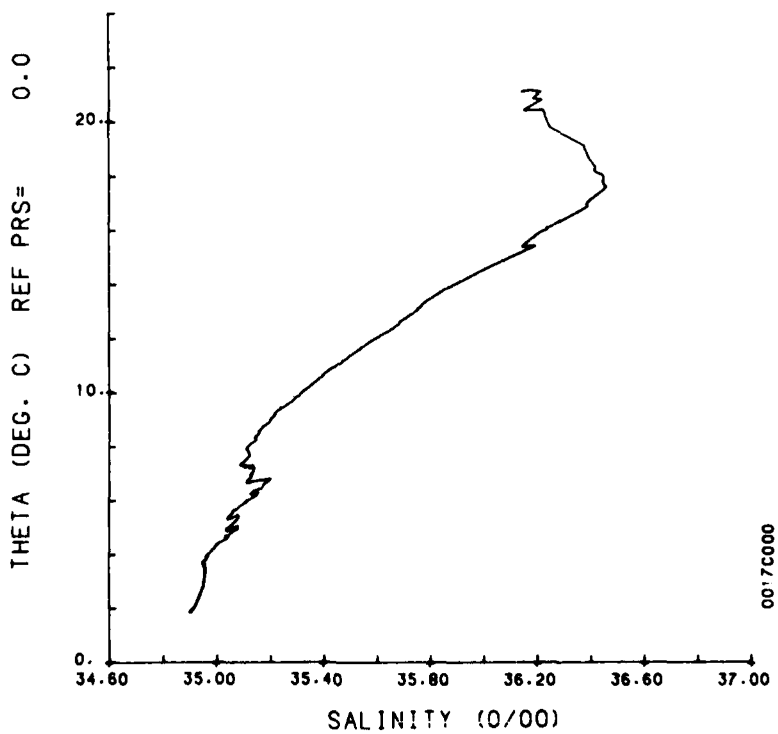


Figure 6: Representative sample of CTD plots and θ-S diagrams located on fiche 2. Station 17 is centrally located in the array.

MOORINGS

Figure 7 shows the depths of the instruments on the moorings and the bottom topography for chosen transects. Table 2 summarizes the mooring statistics.

Details of mooring configuration are shown in Table 3. Mooring items are listed with depths of the instruments underlined and lengths in meters of the other line items.

The anchors for the GSE and NSOI moorings, unless otherwise stated are 3000 lb. wet-weight cylinders. The item "glass balls and chain" refers to glass flotation spheres with hard hats, each one bolted to 3/8" chain at one meter intervals. See Heinmiller (1976) for a more complete description of WHOI moorings.

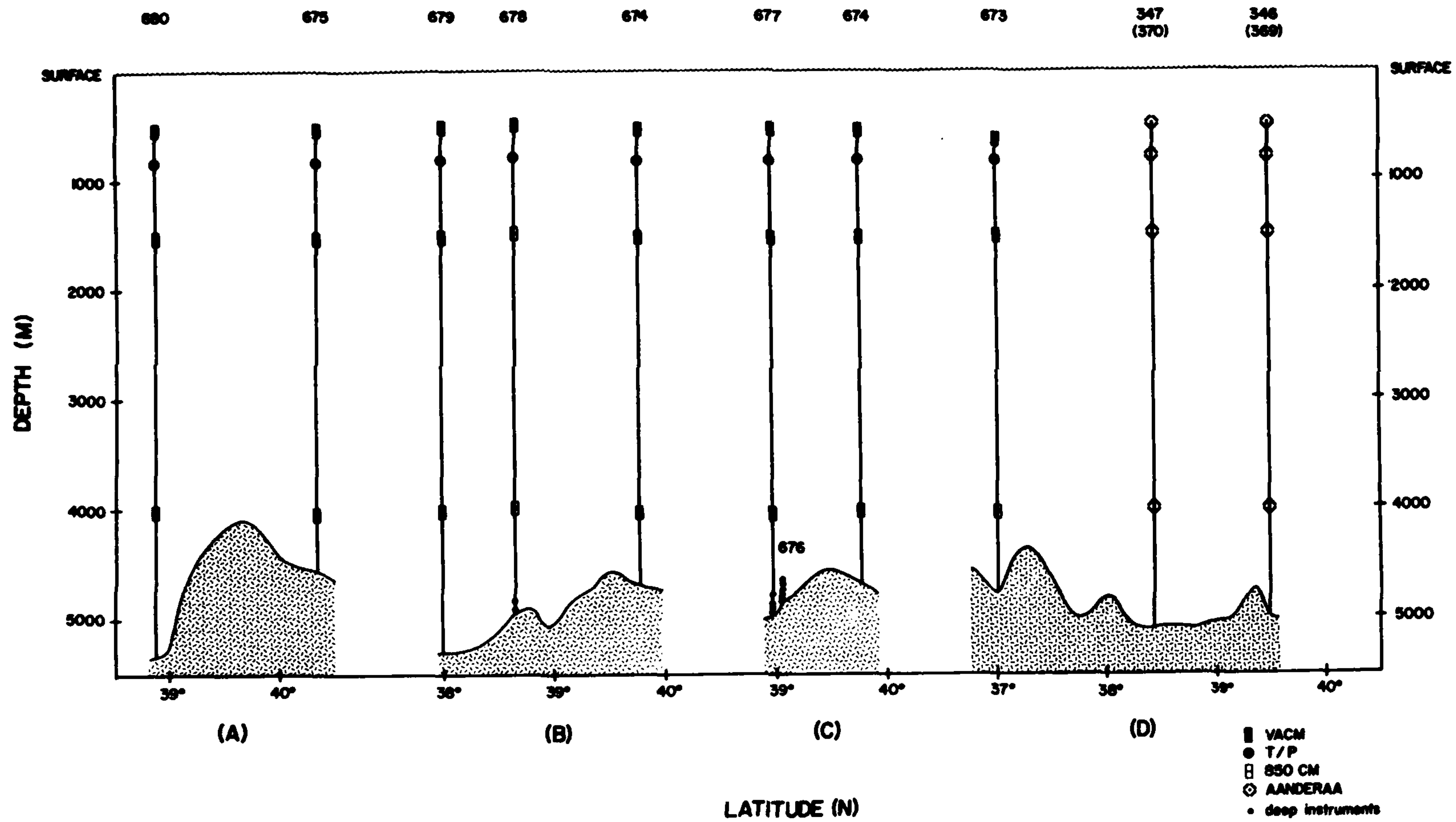


Figure 7: Mooring configuration relative to bottom topography. A through D represent four transects within the array area.

TABLE 2

MOORING STATISTICS

Record No.	Depth (m)	Date Set	Date Ret.	Location	Bottom Depth (m)
WHOI					
6731	641	Oct 23	Nov 25	37 0.1 N	4788
6732	938	1979	1980	42 0.4 W	
6733	1640				
6734	4053				
6741	550	Oct. 25	Nov. 23	39 46.1 N	4695
6742	852	1979	1980	43 56.9 W	
6743	1552				
6744	4029				
6751	569	Oct. 26	Nov. 22	40 22.0 N	4550
6752	866	1979	1980	45 19.9 W	
6753	1564				
6754	4037				
6761	4658	Oct. 24	Nov. 24	39 3.0 N	4841
6762	4697	1979	1980	44 2.0 W	
6763	4747				
6764	4779				
6765	4829				
6766	4830				
6771	560	Oct. 30	Nov. 24	38 58.4 N	4960
6772	858	1979	1980	44 6.6 W	
6773	1497				
6774	4036				
6775	4777				
6776	4857				
6777	4928				
6778	4950				
6781	516	Oct. 31	Nov. 22	38 40.7 N	4944
6782	809	1979	1980	45 37.4 W	
6783	1513				
6784	3995				
6785	4835				
6786	4915				

TABLE 2
(continued)

MOORING STATISTICS

Record No.	Depth (m)	Date Set	Date Ret.	Location	Bottom Depth (m)
WHOI					
6791	519	Nov. 1	Nov. 21	37 58.5 N	5285
6792	817	1979	1980	46 38.0 W	
6793	1516				
6794	4006				
6801	521	Nov. 1	Nov. 20	38 52.5 N	5332
6802	822	1979	1980	46 54.5 W	
6803	1520				
6804	4016				
Bedford Inst.					
3461	500	Sept. 27	APR 30	39 33.8 N	5001
3462	800	1979	1980	42 10.2 W	
3463	1500				
3464	4000				
3471	500	Sept. 26	May 1	38 27.4 N	5089
	800	1979	1980	42 28.5 W	
3472	1500				
3473	4000				
3691	500	May 1	Sept. 14	39 39.5 N	5009
3692	800	1980	1980	42 6.2 W	
	1500				
3693	4000				
3701	500	May 2	Sept. 10	38 29.5 N	5091
3702	800	1980	1980	42 23.4 W	
3703	1500				
3704	4000				

TABLE 3a

WHOI MOORING COMPONENTS

DEPTHS AND LENGTHS (METERS) OF MOORING ITEMS

ITEM	673	674	675	677	678	679	680
Radio float/light	1	1	1	1	1	1	1
Radio							
Light							
3/8" chain	2	2	2	2	2	2	2
3/16" wire	10	10	10	10	10	10	
glass balls/chain	12	10	10	10	10	10	12
VACM	641	550	569	560	516	519	521
3/16" wire	299	298	298	298	298	298	299
T/P	938	852	866	858	809	817	822
3/16" wire	661	662	662	658	658	657	661
glass balls/chain	25	25	25	30	29	28	25
3/16" wire	10	10	10	10	10	10	10
850 CM or VACM	1640	1552	1564	1497	1513	1516	1520
3/16" wire	1000	1000	1000	1000	1000	1000	1000
3/16" wire	1000	1000	1000	1000	1000	1000	1000
3/16" wire	464	463	462	462	462	463	464
glass balls/chain	12	13	15	11	10	11	12
3/16" wire	10	10	10	10	10	10	10
850 CM	4053	4029	4037	4036	3995	4006	4016
3/16" wire	500	500	300	500	500	500	500
3/16" wire	200	10	50	10	50	20	20
3/16" wire	20	100	10	50	10		50
5/8" nylon						5	
3/16" wire		20	20			200	100
3/16" wire			100			500	200
3/16" wire						10	400
glass balls/chain	14	13	12			15	18
3/8" chain		2					
3/16" wire				100	200		
glass balls/chain				20	18		
3/8"wr./thermistor				60	60		
VACM-QT/thermistor				4768	4835		
3/8"wr./thermistor				77.5	77.2		
VACM-QT/thermistor				4848	4915		
3/8"wr./thermistor				77.2			
VACM-QT/thermistor				4928			
3/8"wr./thermistor				20	20		
Neil Brown ACM2				4950			
1/2" chain				1			
Release	1.8	1.8	1.8	1.8	1.8	1.8	1.8
1/2" chain	3	3	3	1	1	3	3
3/4" nylon	10	10	10	3	3	10	10
1/2" chain	5	5	5	2	2	5	5
Anchor	4788	4695	4550	4960	4944	5285	5332

TABLE 3b

WHOI MOORING COMPONENTS

DEPTHS AND LENGTHS (METERS) OF MOORING ITEMS

ITEM	676
Radio float/light	1
Radio	
Light	
3/8" chain	2
3/16" wire	10
glass balls/chain	40
3/8" wr./thermistor	30
VACM-QT /thermistor	4658
3/8"wr. /thermistor	37
VACM-QT /thermistor	4697
3/8"wr. /thermistor	47.5
VACM-QT /thermistor	4747
3/8"wr. /thermistor	30
VACM-QT /thermistor	4779
3/8"wr. /thermistor	47.5
VACM-QT /thermistor	4829
Neil Brown CM ACM2	4830
1/2" chain	1
Release	1.9
3/8" chain	1
5/8" nylon	3
3/8" chain	2
Anchor	4841

TABLE 3c

BIO MOORING COMPONENTS

DEPTHS AND LENGTHS (METERS) OF MOORING ITEMS

Item	346	347	369	370
Disc Buoy				
Radio				
Light				
wire	3	3	3	3
Aanderaa C.M.	501	501	501	501
wire	298	298	298	298
glass ball				
Aanderaa C.M.	801	801	801	801
wire	198	198	198	198
wire	443	443	443	443
2 pkgs. buoyancy				
wire	50	50	50	50
Aanderaa C.M.	1500	1500	1500	1500
wire	2385	2385	2385	2385
2 pkgs. buoyancy				
wire	50	50	50	50
3 pkgs. buoyancy				
wire	50	50	50	50
Aanderaa C.M.	4000	4000	4000	4000
wire	100	100	100	100
2 pkgs. buoyancy				
wire	50	50	50	50
release				
wire	840	940	840	940
anchor	5000	5100	5000	5100

DATA PROCESSING

Data are identified by a mooring number, a sequential instrument position number (e.g., 6733 is the third instrument down on mooring 673), a letter to indicate the data version (e.g., 6733A is the first editing of 6733), and a number to indicate the time sampling interval for that data record (e.g., 6733A900 is the fifteen minute (900 seconds) averaged version).

Current meter tape data were transcribed to 9-track magnetic tapes, converted to scientific units, edited to remove launch and retrieval transients and bad points, and linearly interpolated across missing or erroneous data cycles. Data quality was determined at this point, and is noted in Table 4.

Preliminary T/P cassette reading and data processing were done at MIT. The basic time series received by WHOI were filtered and daily averaged. Basic plots and statistical tables were created for each time series.

Low passed versions of data series were formed by passing the data through a Gaussian filter with a 24 hour half-width, and then subsampling the filtered series once a day. The composite plots shown for each mooring use these filtered data series.

TABLE 4

DATA RETURN AND QUALITY

FILE	START DATE	END DATE	COMMENTS
WHOI			
6731	25-X-79	23-XI-80	All variables look good.
6732	25-X-79	23-XI-80	T/P
6733	25-X-79	23-XI-80	All variables look good.
6734	25-X-79	23-XI-80	All variables look good.
6741	27-X-79	21-XI-80	All variables look good.
6742	28-X-79	21-XI-80	T/P
6743	27-X-79	21-XI-80	Instrument clock 8 hr. 15 min. fast.
6744	27-X-79	21-XI-80	All variables look good.
6751	28-X-79	21-XI-80	All variables look good.
6752	28-X-79	21-XI-80	T/P
6753	28-X-79	21-XI-80	All variables look good.
6754	3-XI-79	20-XI-80	Short; Only direction,temp.
6761	31-X-79	22-XI-80	All variables look good.
6762	31-X-79	22-XI-80	T/P
6763	31-X-79	22-XI-80	All variables look good.
6764	31-X-79	22-XI-80	All variables look good.
6765	31-X-79	22-XI-80	All variables look good.
6771	1-XI-79	22-XI-80	All variables look good. Had 'TILT' variables.
6772	1-XI-79	22-XI-80	T/P
6773	1-XI-79	14-IV-80	Short.
6774	31-X-79	22-XI-80	All variables look good.
6775	31-X-79	22-XI-80	All variables look good.
6776	1-XI-79	22-XI-80	All variables look good.
6777	1-XI-79	22-XI-80	All variables look good.
6781	2-XI-79	20-XI-80	Short temperature and pressure.
6782	2-XI-79	20-XI-80	T/P
6783	2-XI-79	20-XI-80	All variables look good.
6784	2-XI-79	10-XI-80	Low order bits missing in all variables. Data less precise.
6785	2-XI-79	20-XI-80	All variables look good.
6786	2-XI-79	20-XI-80	All variables look good.

DATA RETURN (continued)

FILE	START DATE	END DATE	COMMENTS
6791	3-XI-79	19-XI-80	All variables look good.
6792	3-XI-79	19-XI-80	T/P
6793	3-XI-79	19-XI-80	All variables look good.
6794AA	3-XI-79	22-I-80	Split data. Speed values at
6794AB	9-VI-80	19-XI-80	threshold. Full temp. values
6801	3-XI-79	19-XI-80	All variables look good.
6802	4-XI-79	19-XI-80	T/P
6803	3-XI-79	19-XI-80	All variables look good.
6804	3-XI-79	19-XI-80	Not 'A' quality data.
Bedford Inst.			
3461	28-IX-79	28-IV-80	
3462	28-IX-79	28-IV-80	
3463	28-IX-79	28-IV-80	
3464	28-IX-79	28-IV-80	
3471	27-IX-79	29-IV-80	
3472	27-IX-79	29-IV-80	
3473	27-IX-79	30-IV-80	
3691	2-V-80	14-IX-80	Fouled externally by attached line. No useful speed or direction. Did get temp., press., cond.
3692	2-V-80	14-IX-80	
3693	2-V-80	14-IX-80	
3701	3-V-80	10-IX-80	
3702	3-V-80	10-IX-80	
3703	3-V-80	10-IX-80	
3704	3-V-80	10-IX-80	

Note:

The 800 meter instrument on mooring 347 had a jammed tape transport and no data were obtained.

The 1500 meter instrument on mooring 369 flooded and no data were obtained.

Depth

Depth for the current meters were computed using a standard procedure. Before launch, water depth at the anticipated anchor location was read from a depth recorder at sea. The mooring components were adjusted to bring the instruments as close as possible to the nominal depths. The recorded lengths of all the mooring components became input for the program NOYFB (Moller,1976) and actual instrument depths were calculated.

All depths listed in the tables are corrected instrument depths for the GSE moorings. Depth is computed using the Saunders and Fofonoff method (1976) including the dynamic height correction for the central North Atlantic. Table 5 lists the corrected depths, the NOYFB calculated instrument depths and their differences.

GSE INSTRUMENT DEPTHS

Data Name	Insrument	NOYFB Depth	Corrected Depth	%D
6731	V163P	526 m	641 m	+115 m
6732	TP#72	826	938	+112
6741	V119P	523	550	+ 27
6742	TP#80	822	852	+ 30
6751	V112P	530	569	+ 39
6752	TP#77	829	866	+ 37
6753	V181P	1530	1564	+ 34
6771	V113P	530	560	+ 30
6772	TP#3	830	858	+ 28
6773	V114P	1530	1497	- 33
6781	V183P	491	516	+ 25
6782	TP#78	791	809	+ 18
6791	V107P	506	519	+ 13
6792	TP#34	806	817	+ 11
6801	V134P	512	521	+ 9
6802	TP#79	812	822	+ 10
6803	V115P	1512	1520	+ 8

TABLE 5: Calculated and corrected instrument depths for the GSE moorings, and their differences. Corrected instrument depths are derived by noting the depth of the histogram peak. The peaks are quite sharp, permitting resolution of ± 0.5 m and in almost all cases occur only 2-3 m deeper than the shallowest depth of the instrument. Depth accuracy is ± 3 m at 500 m and about ± 6 m at 800 and 1500 m.

PROGRAMS

Time Series

Current components are plotted as individual vectors along a time axis. The stick plots, displayed on Fiche 2 through 5 are plotted so that North is up, relative to the time axis. The composite stick diagrams in Figures 8 through 26 are plotted such that East is up.

Individual current meter and T/P variables are plotted against time from one day Gaussian filtered series. See Figures 8 through 26 on the printed pages and Rows D and G on Fiche 2 through 5.

Statistics

Statistics are computed for both T/P and current meter data. The basic T/P data was recorded every 1920 seconds, the WHOI VACM recorded data every 900 seconds, the Model 850 recorded data each hour and the BIO instrument sampling intervals were either half an hour or one hour. Mean, standard error, variance, kurtosis and extrema are computed. East and north covariance, correlation and other statistics are given for the vectors. For reference, note that a Gaussian random variable would have a kurtosis of three and a skewness of zero.

Statistical tables are shown in Fiche 2 through 5, in Row A.

See Volume XVII (POLYMODE Array II) of this series for a more detailed discussion of these parameters.

Histograms

The variables temperature, velocity components, speed and direction are shown as frequency of occurrence versus amplitude plots. The mean for each data series is marked. They are shown in Row B of Fiche 2 through 5. None is shown for the second BIO setting.

Progressive Vector and Scatter Plots

Progressive vector plots are based on the unfiltered time series. The current vectors are placed tail-to-head so as to show the path that a perfect particle in a perfectly homogeneous flow would have travelled. Flow regimes and low frequency behavior show up well on this type of plot. The plot begins with an asterisk, the first day of each month is marked with a triangle and every month is annotated.

Every daily averaged point from the series is plotted in a scatter plot, in which east and north components are plotted as points on a polar diagram. The line drawn through the points is the principal axis. It has slope theta ($\hat{\theta}$) (where theta is given by $\tan(2\hat{\theta}) = (2\overline{uv}) / (\overline{u^2} - \overline{v^2})$) and it passes through the point $(\overline{U},\overline{V})$.

Progressive vectors and scatter plots are shown in Row C of Fiche 2 through 5.

Spectra

The horizontal kinetic energy (HKE) and temperature are displayed as spectra. The HKE spectrum is half of the sum of the spectra of the east and north components. It has the advantage of not being tied to a particular coordinate system. These plots are shown in the fiche.

The HKE and temperature have units of either $(cm^2/sec^2)/cph$ or $(m^2/sec^2)/cph$, and $(°C)^2/cph$ respectively. The spectra are all one-sided, i.e., the area under the spectrum is equal to the variance of the original record. The plots are log-log rather than 'variance preserving', i.e., the contributions of various frequency bands to the total variance are not in proportion to the displayed areas. They are shown on Fiche 2 through 5 in Row A.

Streamfunctions

An objective mapping program (OMF) is used to create a series of streamfunctions, subsampled every five days. Current vectors and mooring locations are included in these plots of cyclonic and anti-cyclonic eddies and general water movement. These streamfunction plots are located in Figures 30 through 32.

Phase Diagrams

Another program sampling this data (XTPLOT) takes the streamfunction plots one step further and looks at one latitude position across many longitudes, and vice versa, throughout the data series at the same five day intervals as presented in the streamfunction plots. These composite plots of water movement are located in Figures 33 through 38.

REFERENCES

Brown, N., 1975, A precision CTD microprofiler. WHOI Ref. 75-18 (Technical Report).

Heinmiller, R. H., 1976, Woods Hole Buoy Project Moorings, 1960-1974. WHOI Ref. 76-53 (Technical Report).

Moller, D. A., A computer program for the design and static analysis of single-point subsurface mooring systems: NOYFB. WHOI Ref. 76-59 (Technical Report).

Payne, R. E., A. L. Bradshaw, J. P. Dean and K. E. Schleicher, 1976, Accuracy of temperature measurements with the V.A.C.M. WHOI Ref. 76-94 (Technical Report).

Saunders, P. M. and N. P. Fofonoff, 1976, Conversion of pressure to depth in the ocean. Deep Sea Research, 23, 109-112.

Wunsch, C. and J. Dahlen, 1974, A moored temperature and pressure recorder. Deep Sea Research, 21, 145-154.

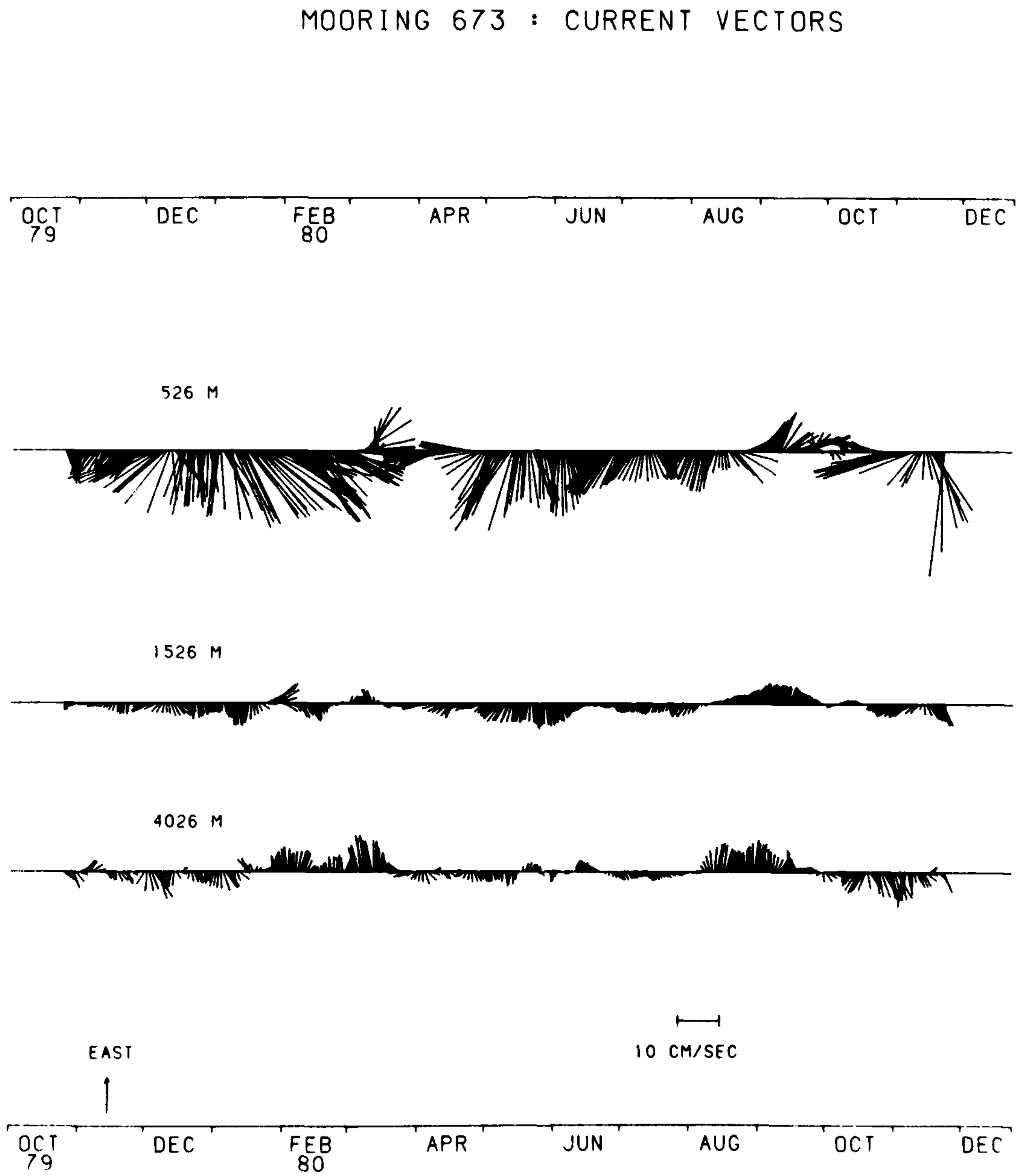

MOORING 673 : CURRENT VECTORS
OCT 79
DEC
FEB 80
APR
JUN
AUG
OCT
DEC
526 M
1526 M
4026 M
10 CM/SEC
EAST

Figure 8

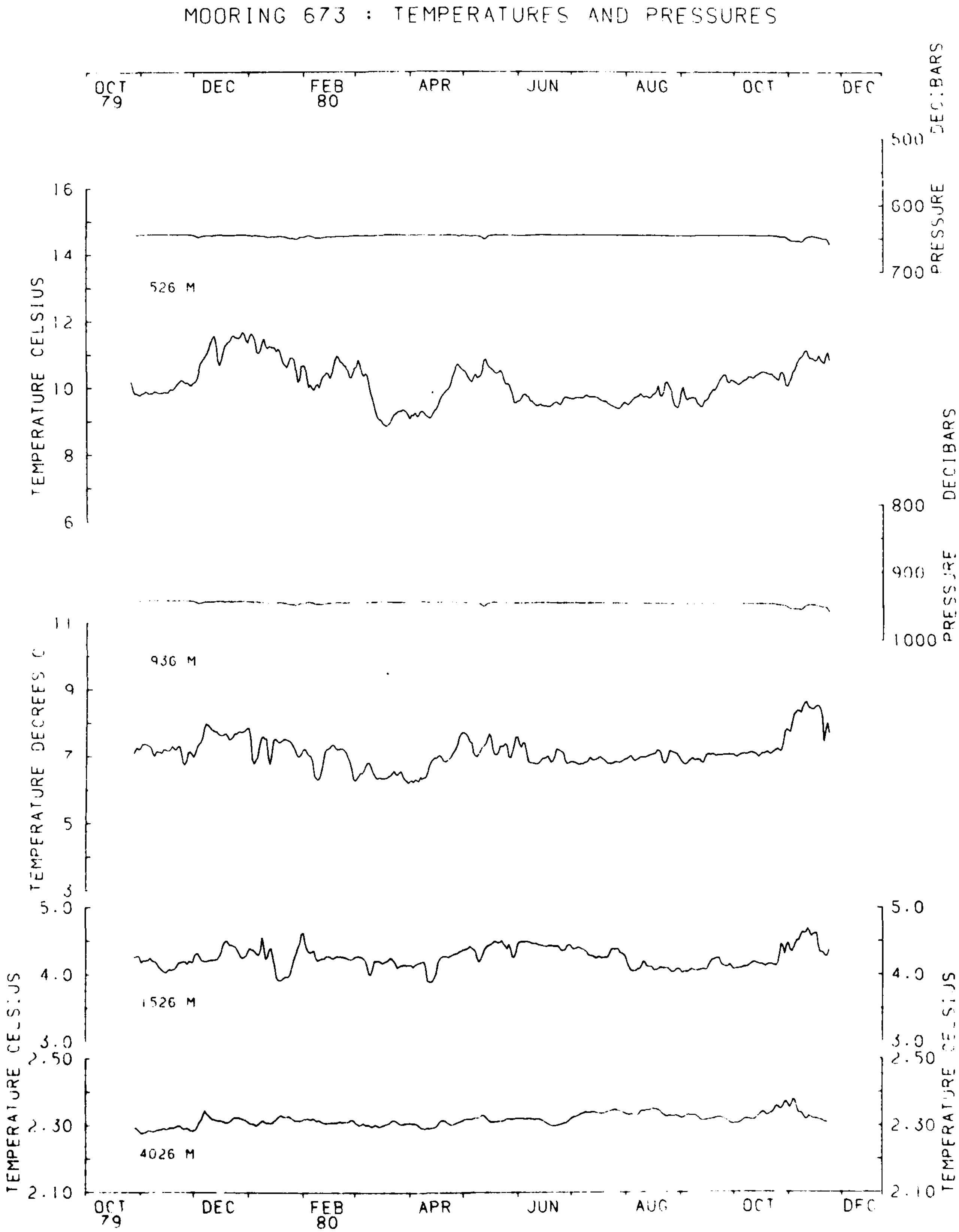

MOORING 673 : TEMPERATURES AND PRESSURES
OCT 79
DEC
FEB 80
APR
JUN
AUG
OCT
DEC
DECIBARS
500
600
700
PRESSURE
16
14
12
10
8
6
TEMPERATURE CELSIUS
526 M
800
900
1000
PRESSURE
DECIBARS
11
9
7
5
3
TEMPERATURE DEGREES C
936 M
5.0
4.0
3.0
1526 M
2.50
2.30
2.10
4026 M
TEMPERATURE CELSIUS

Figure 9

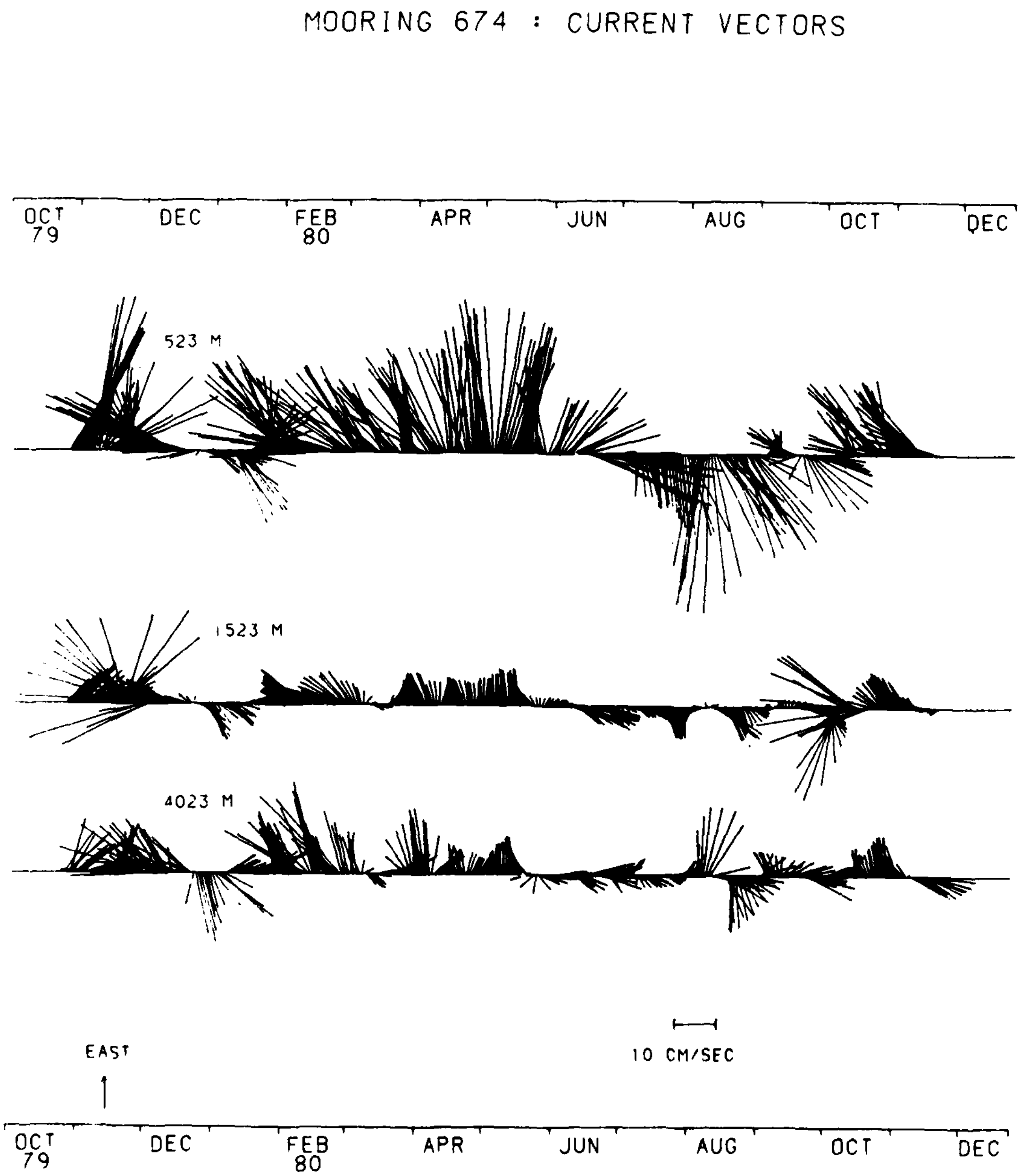

MOORING 674 : CURRENT VECTORS
OCT 79
DEC
FEB 80
APR
JUN
AUG
OCT
DEC
523 M
1523 M
4023 M
EAST
10 CM/SEC

Figure 10

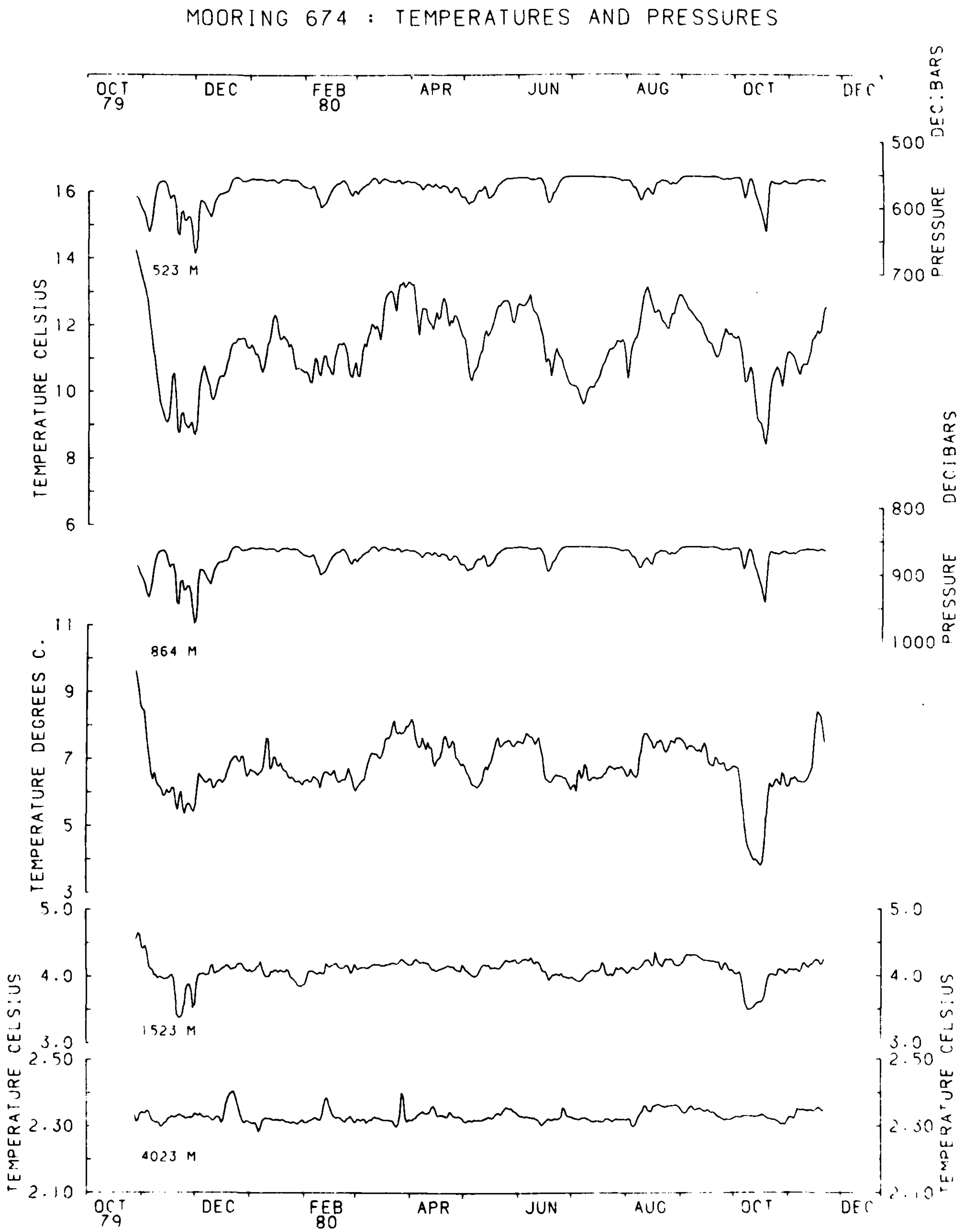

MOORING 674 : TEMPERATURES AND PRESSURES
OCT 79
DEC
FEB 80
APR
JUN
AUG
OCT
DEC
DECIBARS
PRESSURE
500
600
700
16
14
12
10
8
6
TEMPERATURE CELSIUS
523 M
800
900
1000
11
9
7
5
3
TEMPERATURE DEGREES C.
864 M
5.0
4.0
3.0
1523 M
2.50
2.30
2.10
4023 M
TEMPERATURE CELSIUS

Figure 11

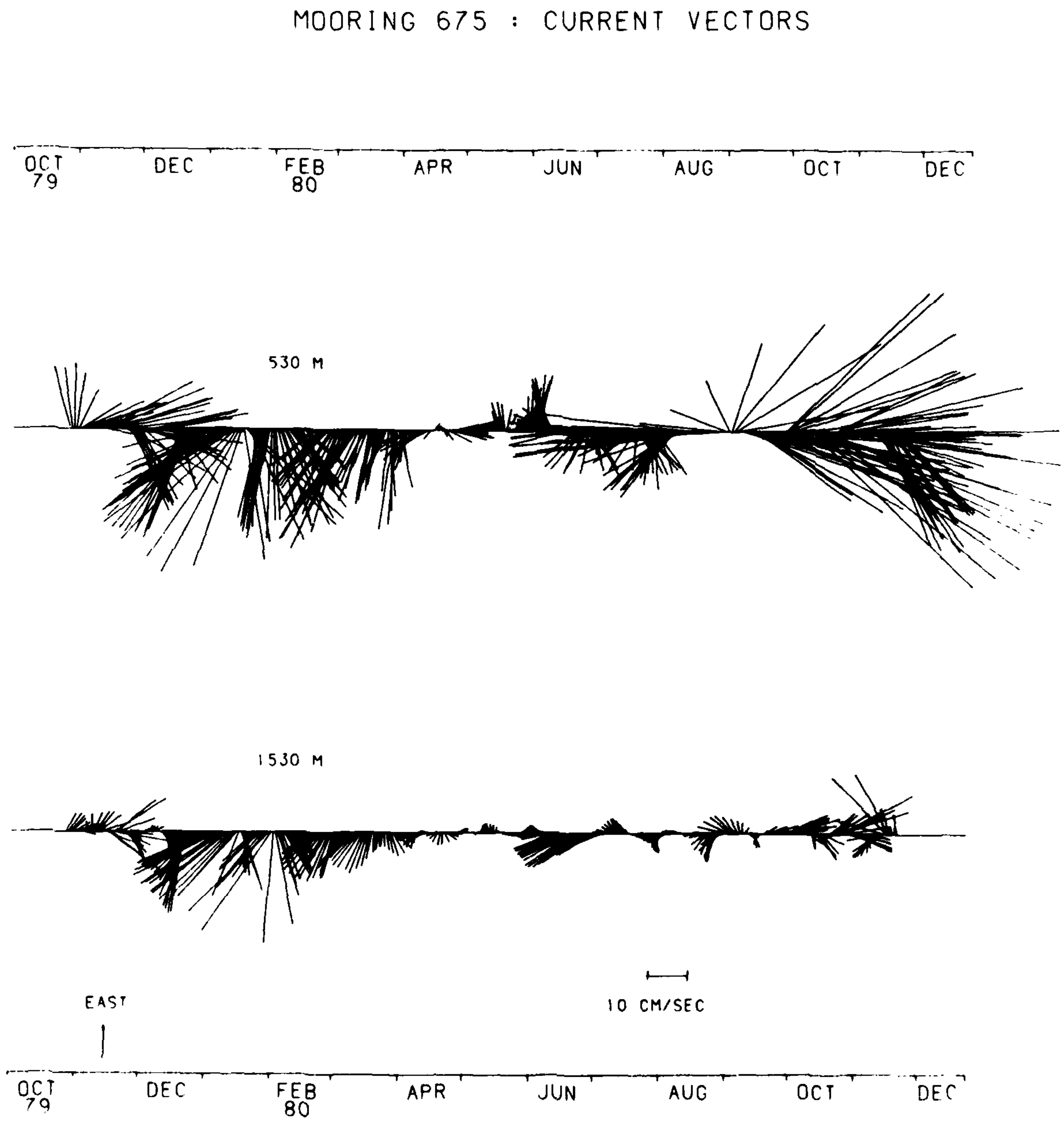

MOORING 675 : CURRENT VECTORS
OCT 79
DEC
FEB 80
APR
JUN
AUG
OCT
DEC
530 M
1530 M
EAST
10 CM/SEC
OCT 79
DEC
FEB 80
APR
JUN
AUG
OCT
DEC

Figure 12

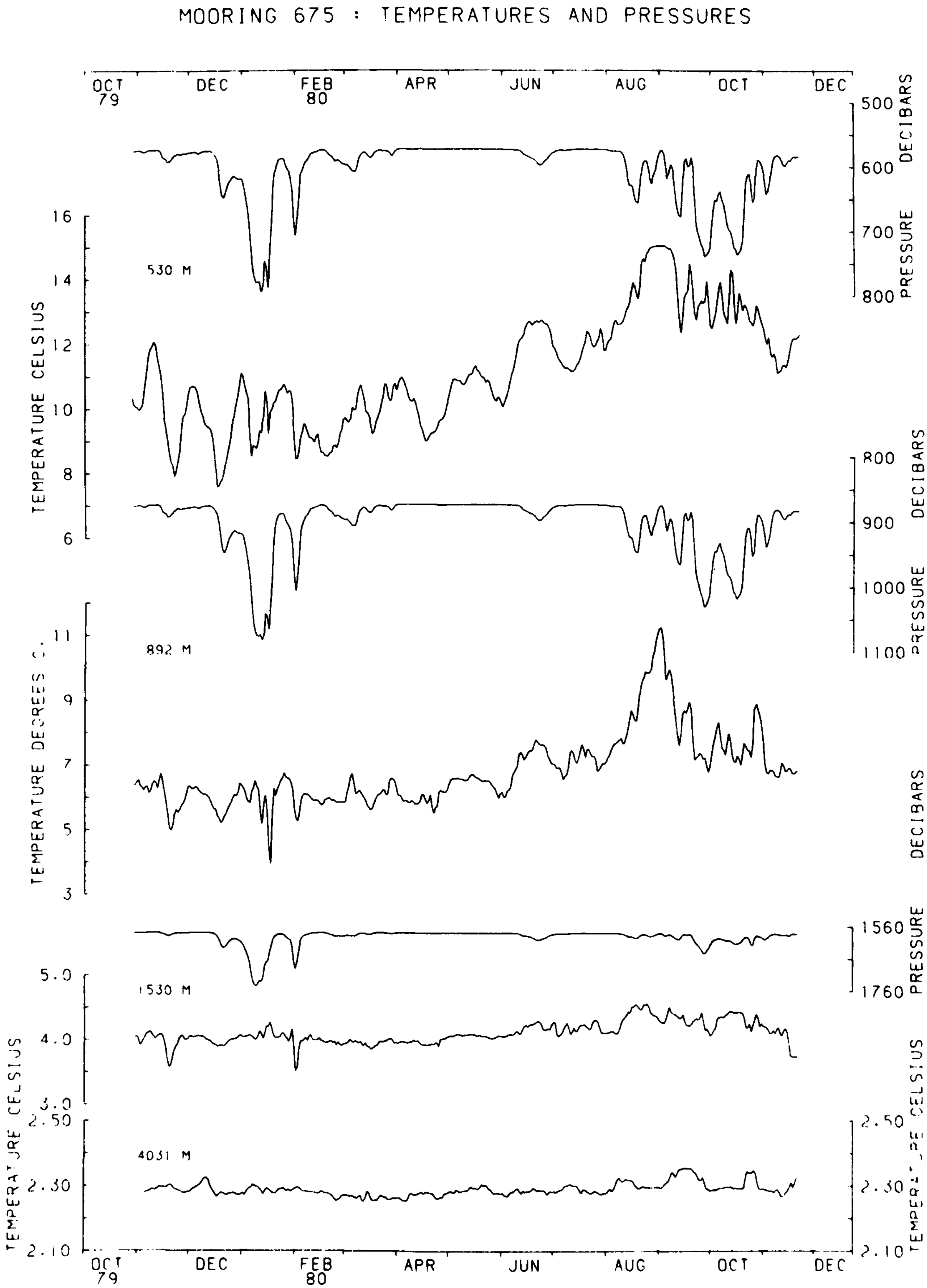

MOORING 675 : TEMPERATURES AND PRESSURES
OCT 79
DEC
FEB 80
APR
JUN
AUG
OCT
DEC
PRESSURE DECIBARS
500
600
700
800
TEMPERATURE CELSIUS
16
14
12
10
8
6
530 M
900
1000
1100
892 M
11
9
7
5
3
1560
1760
5.0
4.0
3.0
1530 M
2.50
2.30
2.10
4031 M

Figure 13

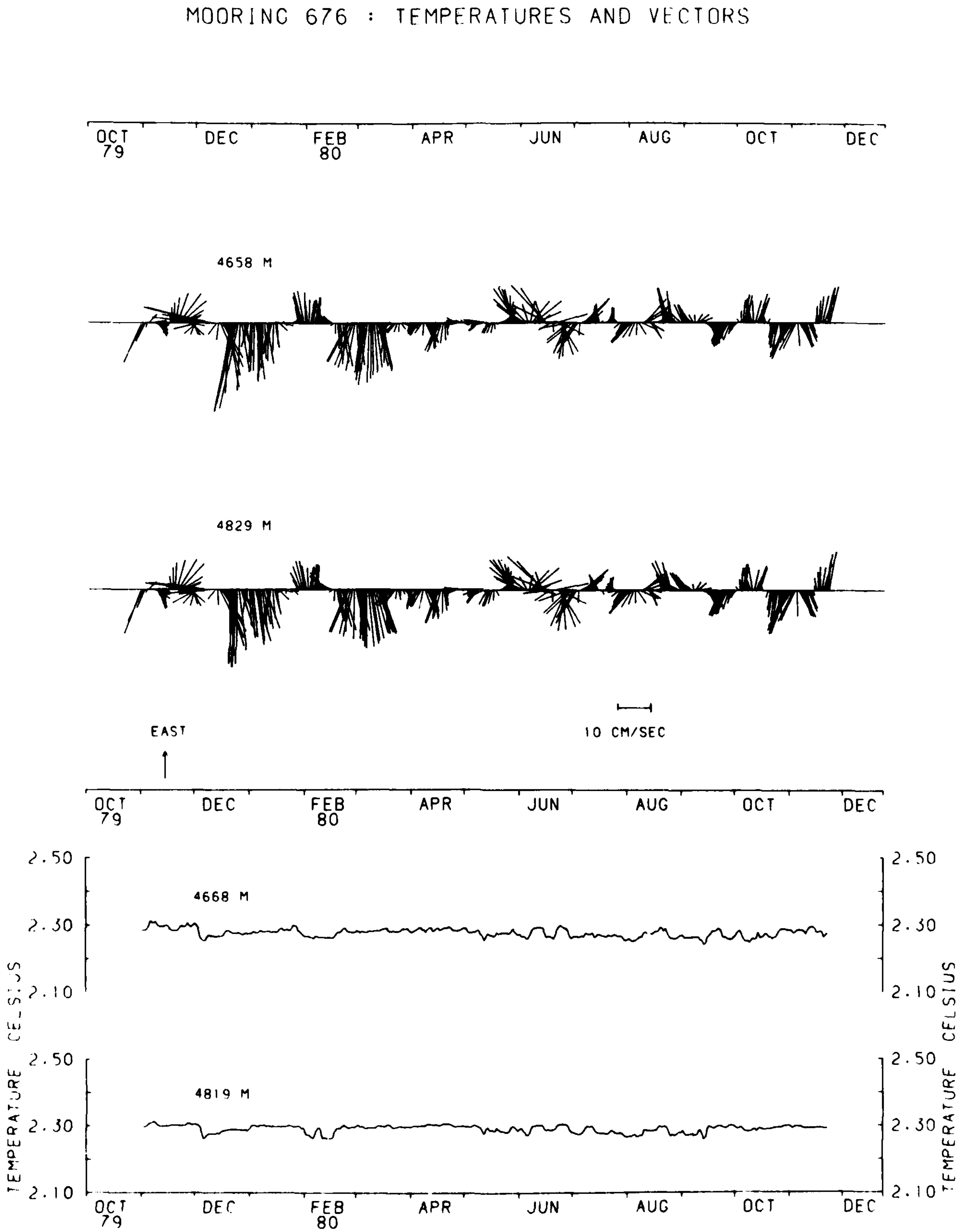
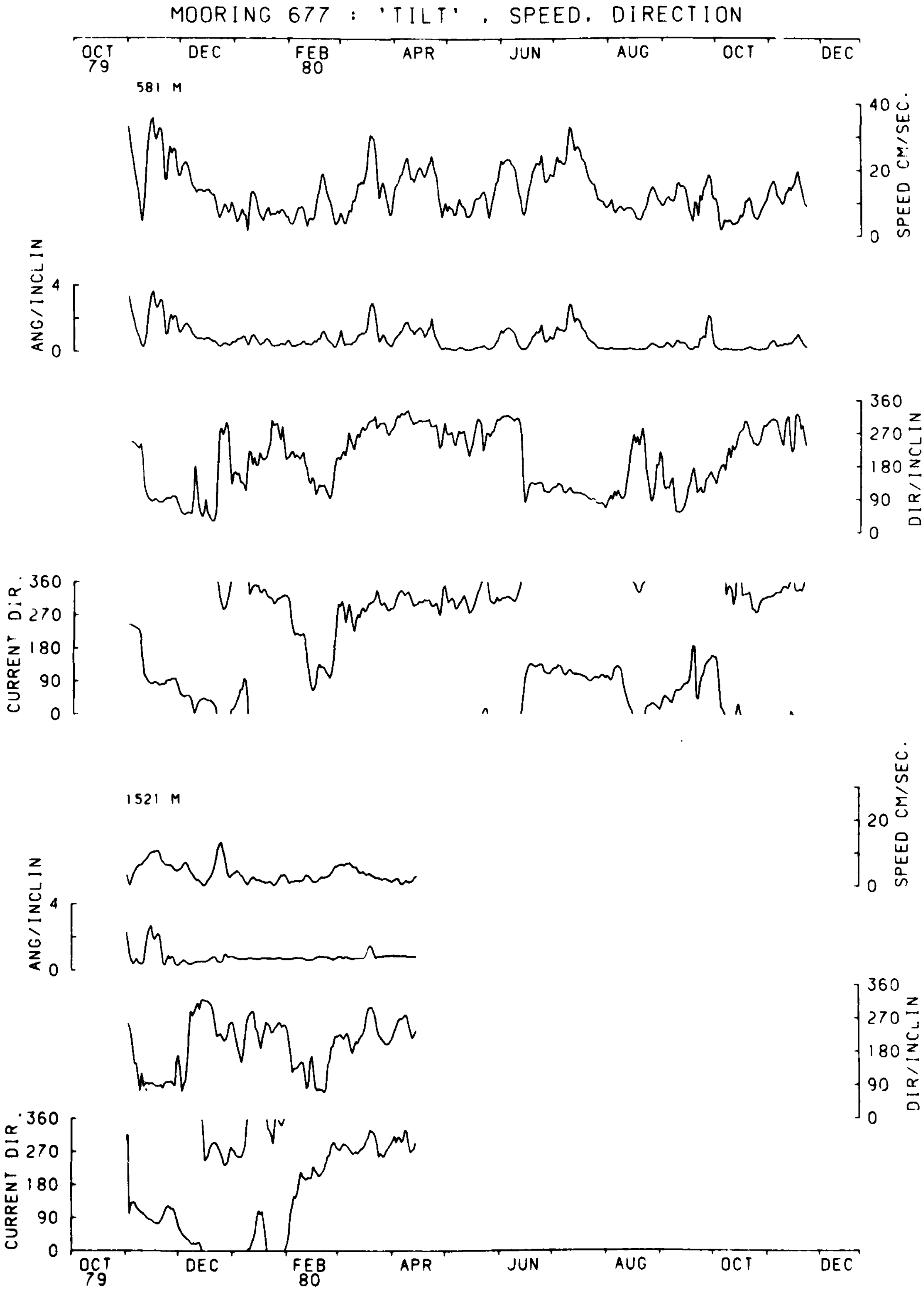

MOORING 676 : TEMPERATURES AND VECTORS
OCT 79
DEC
FEB 80
APR
JUN
AUG
OCT
DEC
4658 M
4829 M
EAST
10 CM/SEC
2.50
2.30
2.10
4668 M
4819 M
TEMPERATURE CELSIUS

Figure 14



MOORING 677 : 'TILT' , SPEED, DIRECTION
OCT 79
DEC
FEB 80
APR
JUN
AUG
OCT
DEC
581 M
40
20
0
SPEED CM/SEC.
ANG/INCLIN
4
0
360
270
180
90
0
DIR/INCLIN
CURRENT DIR.
360
270
180
90
0
1521 M
20
0
SPEED CM/SEC.
ANG/INCLIN
4
0
360
270
180
90
0
DIR/INCLIN
CURRENT DIR.
360
270
180
90
0
OCT 79
DEC
FEB 80
APR
JUN
AUG
OCT
DEC

Figure 15

MOORING 677 : CURRENT VECTORS

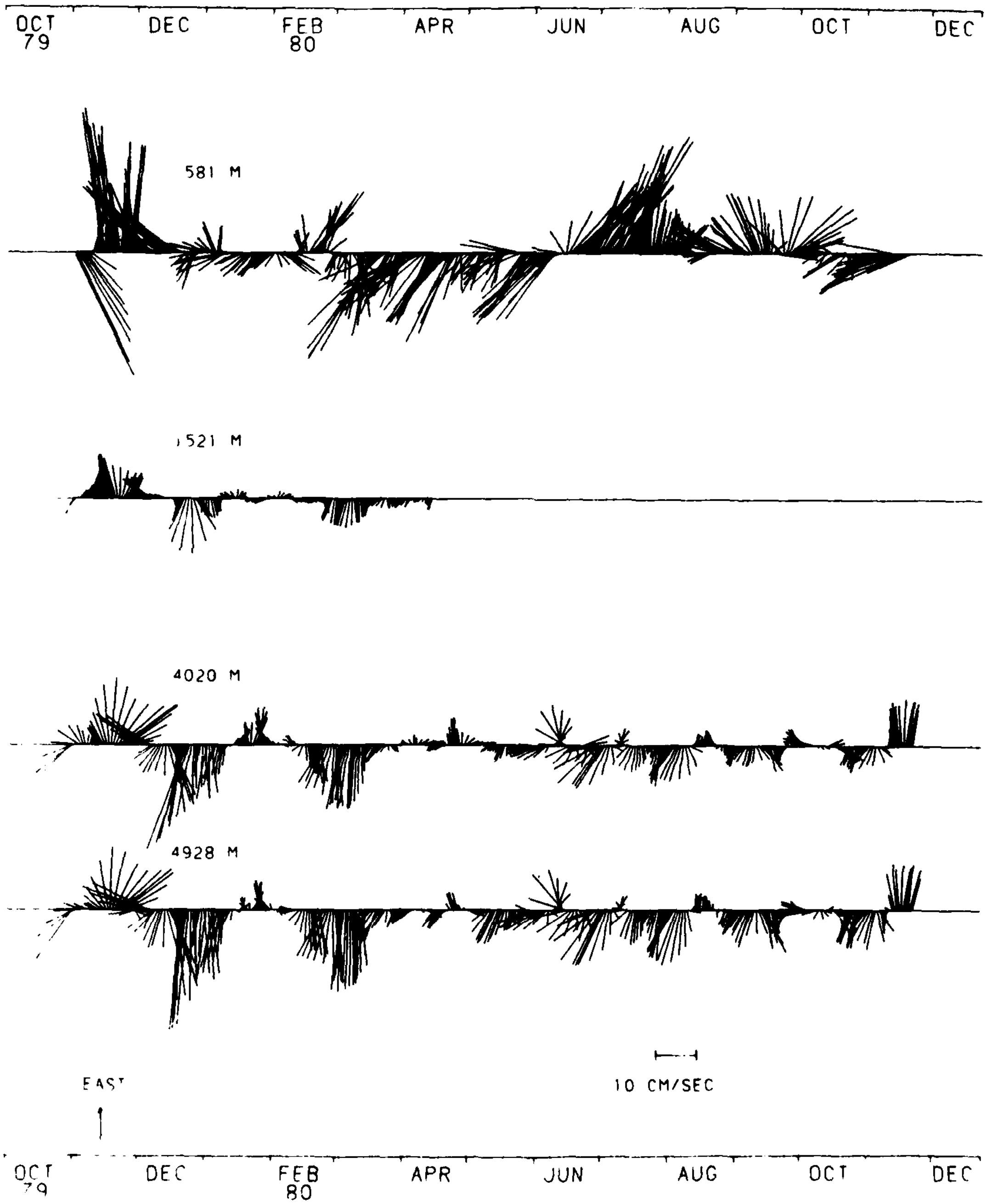


Figure 16

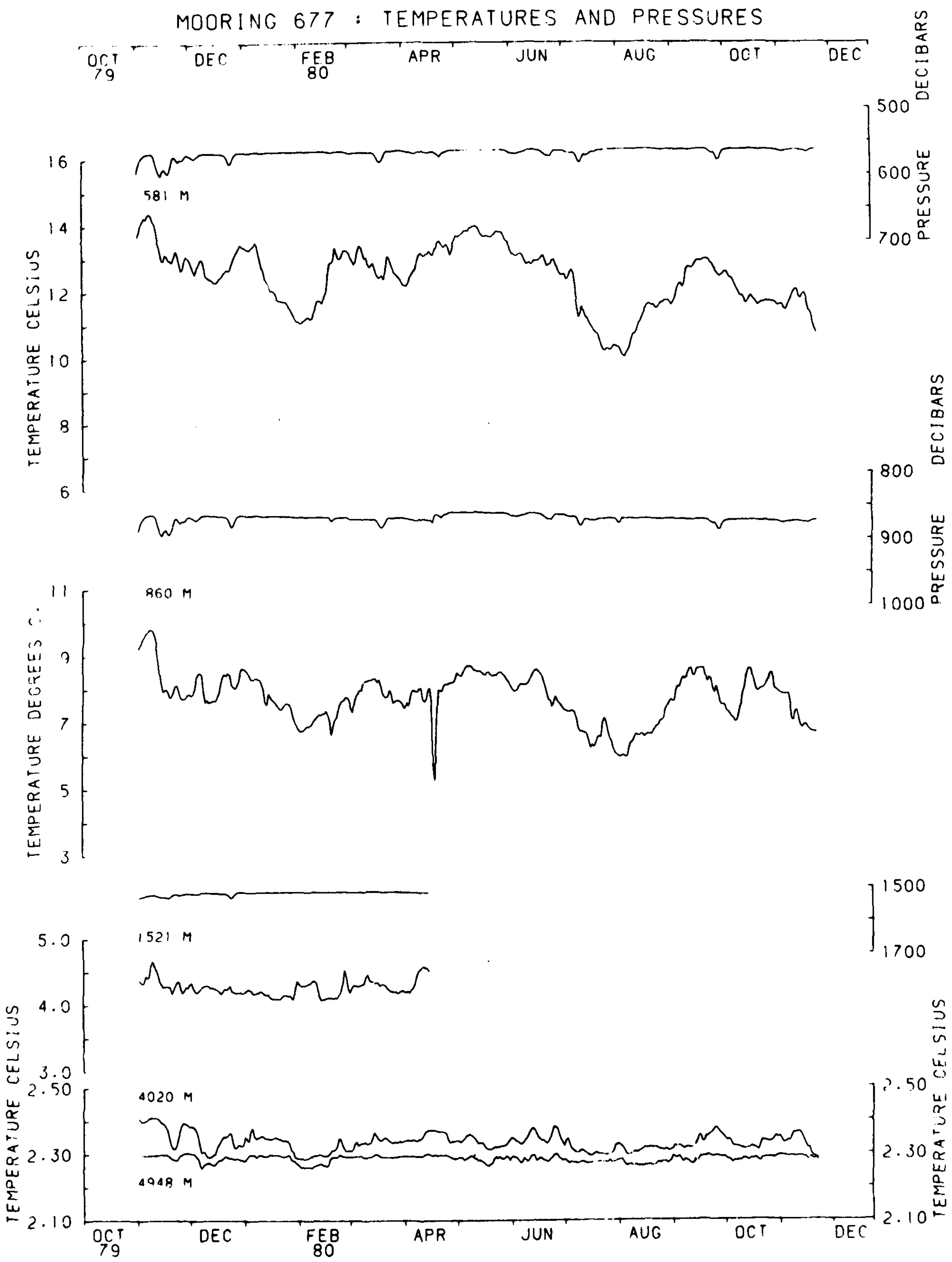

MOORING 677 : TEMPERATURES AND PRESSURES
OCT 79
DEC
FEB 80
APR
JUN
AUG
OCT
DEC
DECIBARS
PRESSURE
500
600
700
16
14
12
10
8
6
TEMPERATURE CELSIUS
581 M
800
900
1000
860 M
11
9
7
5
3
TEMPERATURE DEGREES C.
1500
1700
1521 M
5.0
4.0
3.0
2.50
2.30
2.10
4020 M
4948 M

Figure 17

MOORING 678 : CURRENT VECTORS

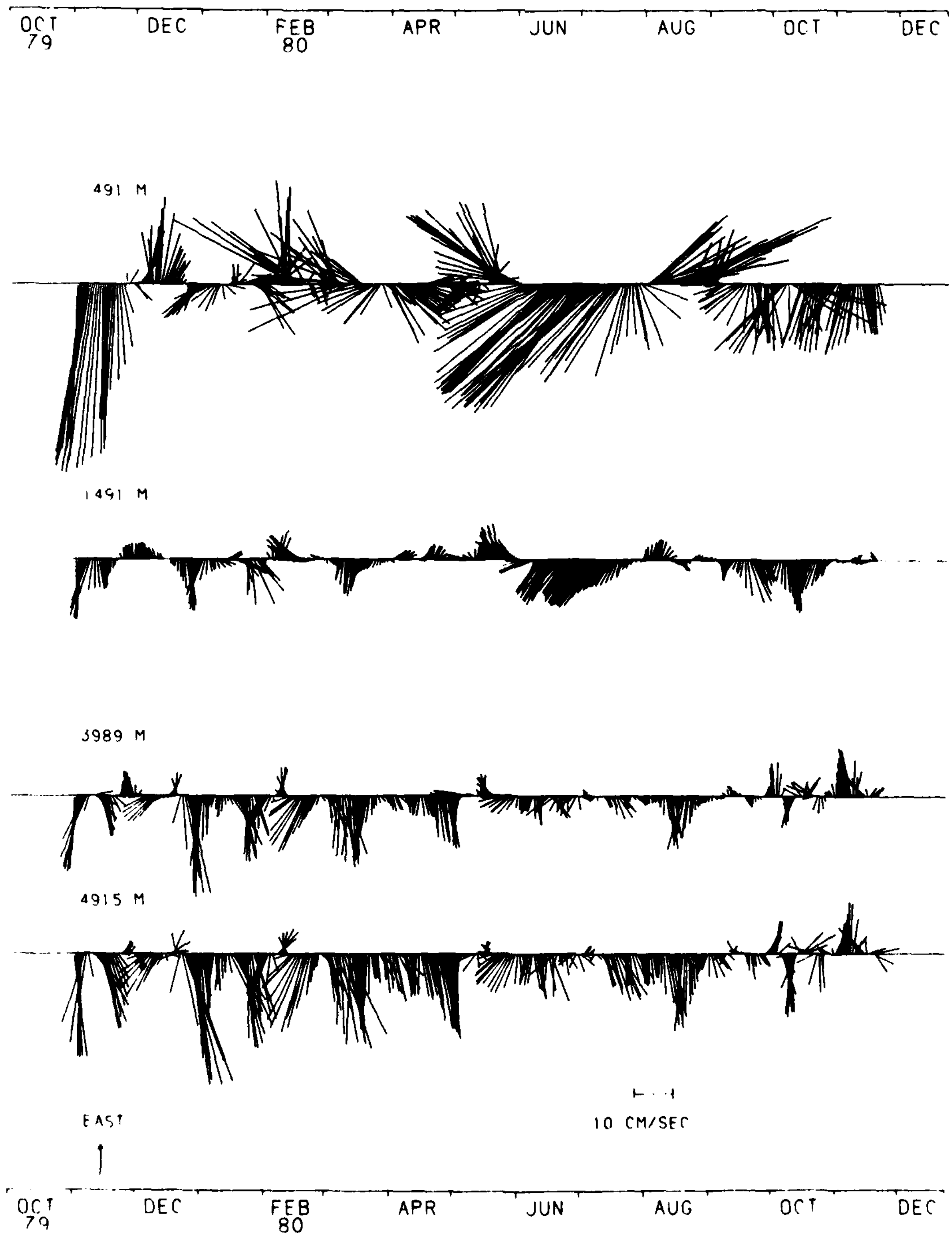


Figure 18

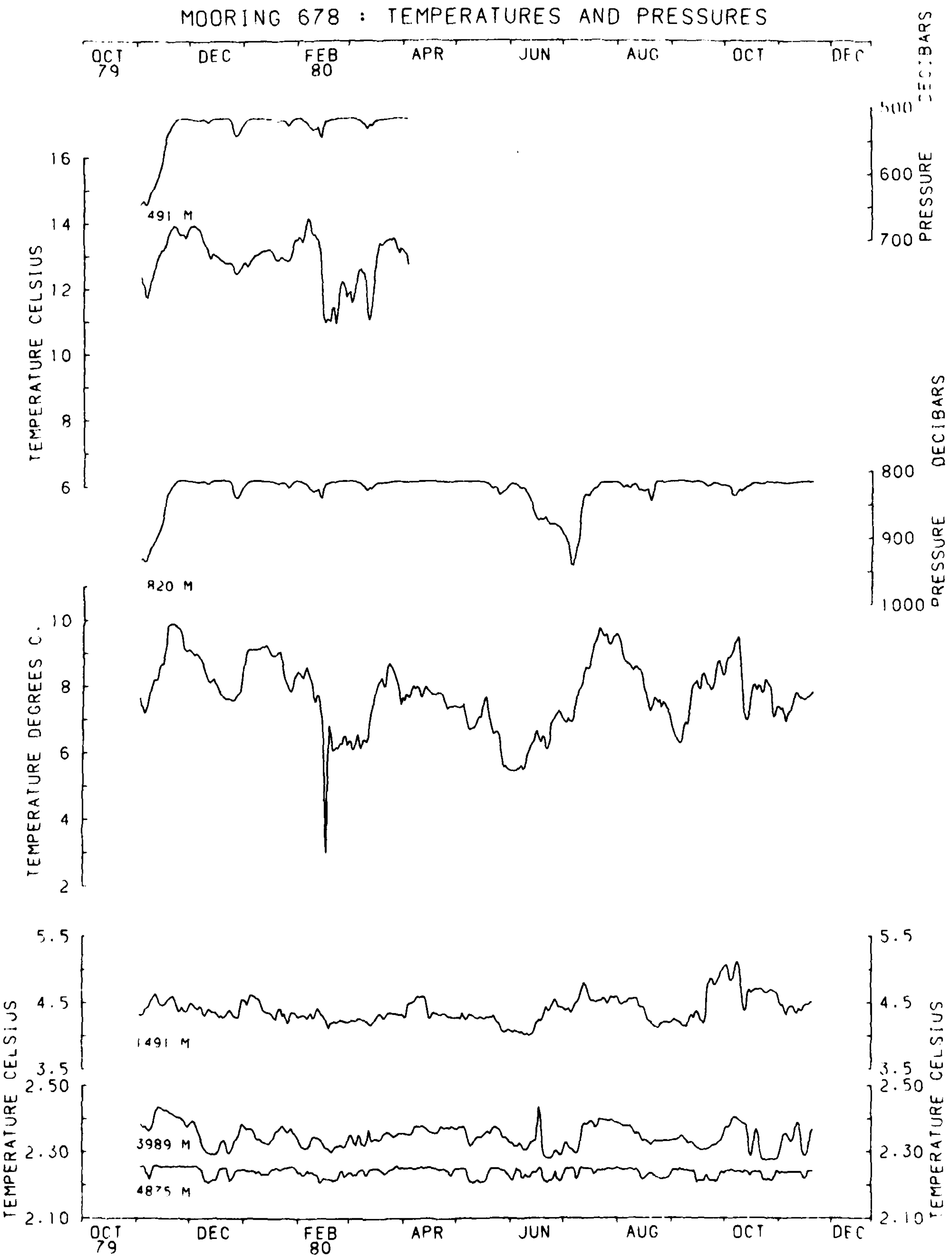

MOORING 678 : TEMPERATURES AND PRESSURES
OCT 79
DEC
FEB 80
APR
JUN
AUG
OCT
DEC
PRESSURE DECIBARS
500
600
700
16
14
12
10
8
6
TEMPERATURE CELSIUS
491 M
800
900
1000
820 M
TEMPERATURE DEGREES C.
4
2
5.5
4.5
3.5
1491 M
2.50
2.30
2.10
3989 M
4875 M

Figure 19

MOORING 679 : CURRENT VECTORS

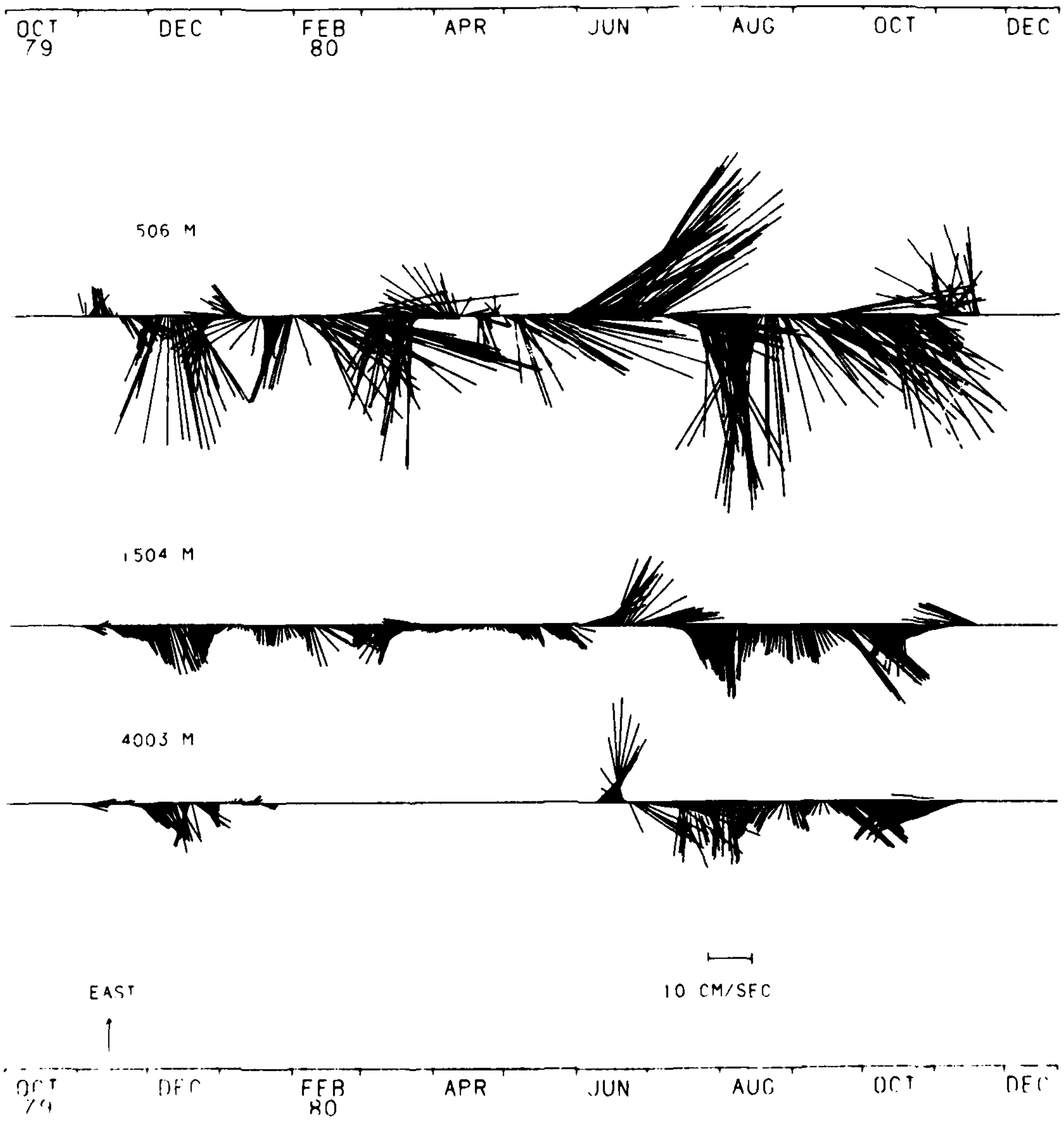


Figure 20

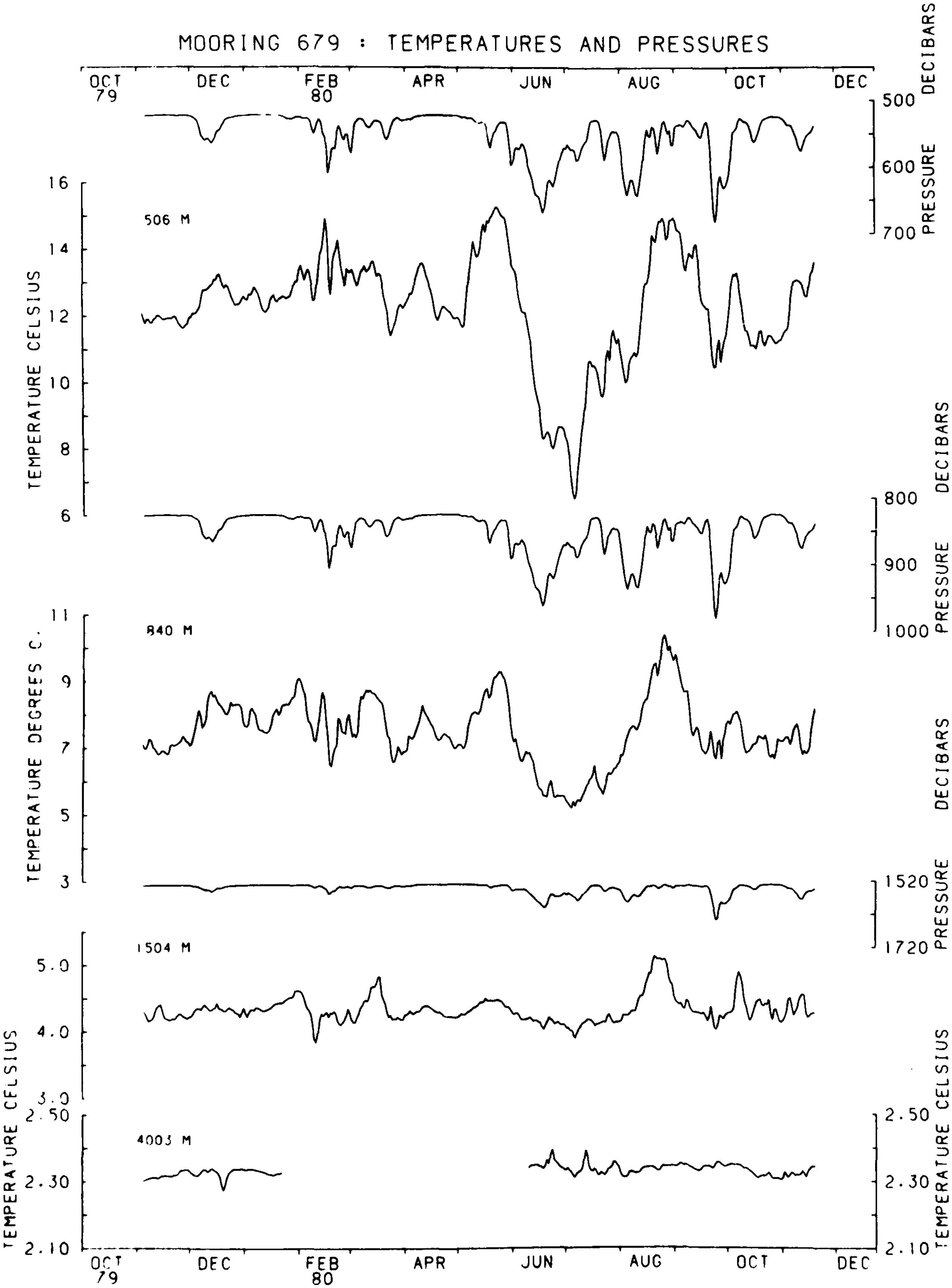

MOORING 679 : TEMPERATURES AND PRESSURES
OCT 79
DEC
FEB 80
APR
JUN
AUG
OCT
DEC
PRESSURE DECIBARS
500
600
700
506 M
TEMPERATURE CELSIUS
16
14
12
10
8
6
800
900
1000
840 M
TEMPERATURE DEGREES C.
11
9
7
5
3
1520
1720
1504 M
5.0
4.0
3.0
4003 M
2.50
2.30
2.10

Figure 21

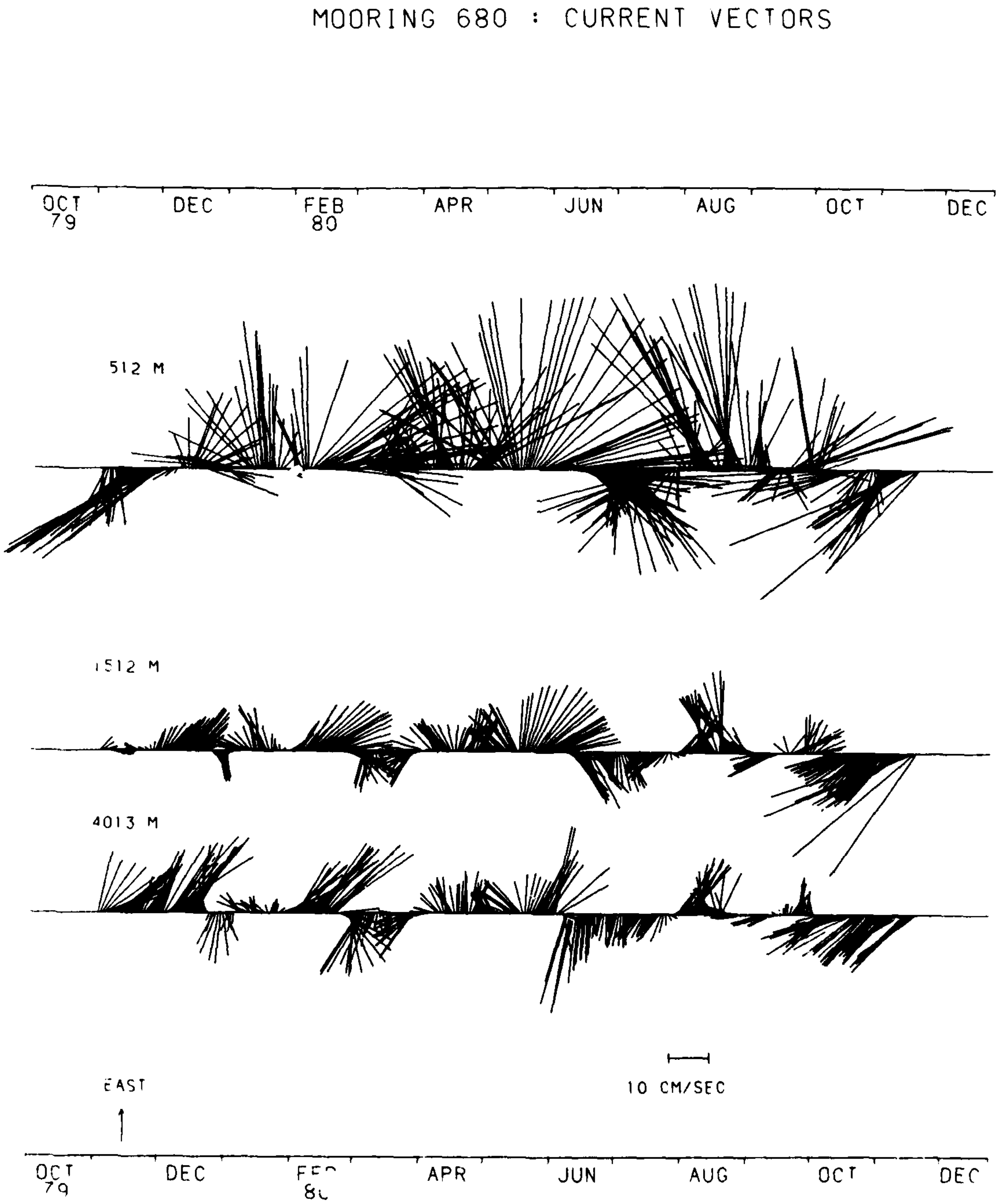

MOORING 680 : CURRENT VECTORS
OCT 79
DEC
FEB 80
APR
JUN
AUG
OCT
DEC
512 M
1512 M
4013 M
EAST
10 CM/SEC

Figure 22

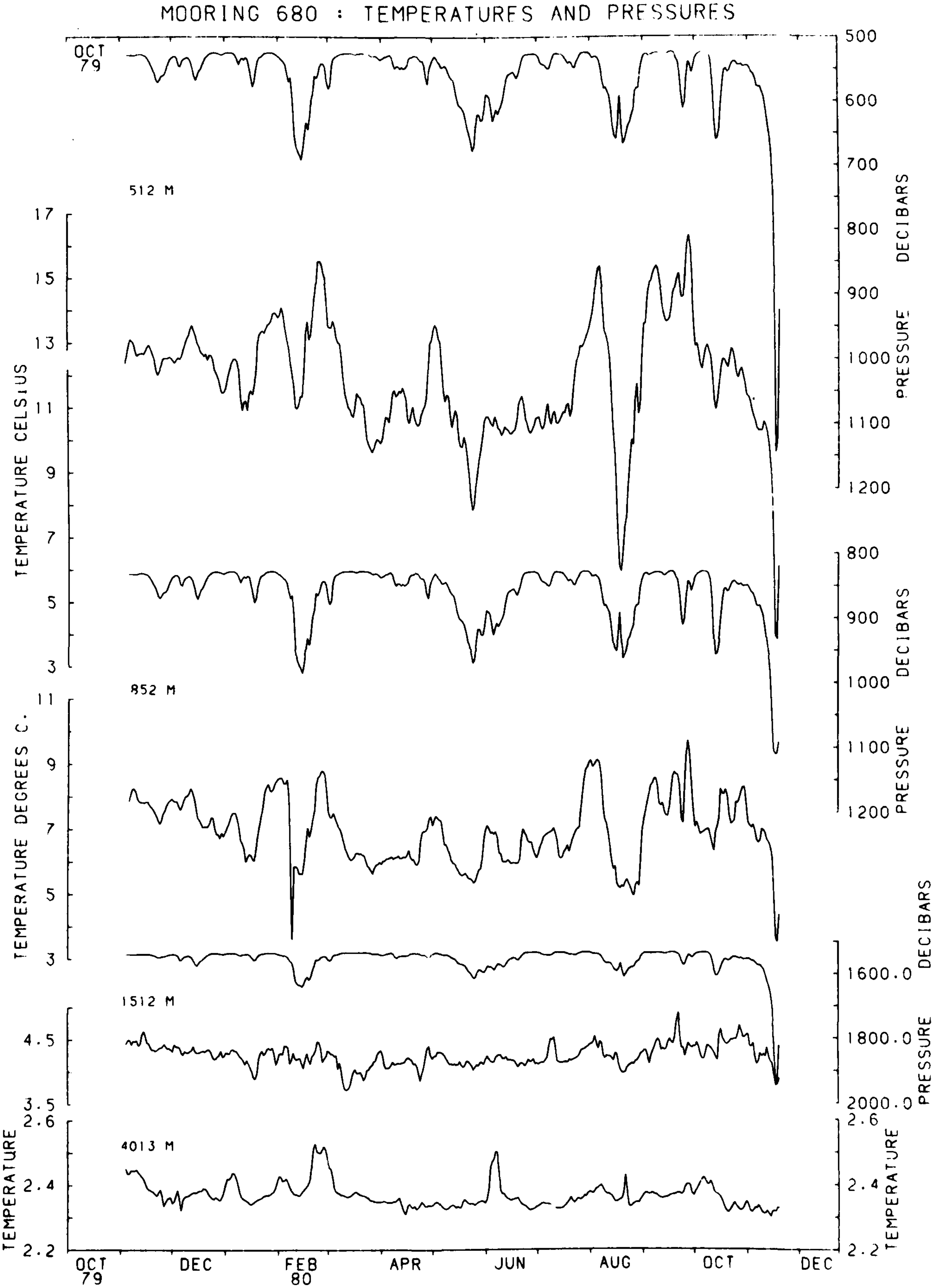

MOORING 680 : TEMPERATURES AND PRESSURES
OCT 79
512 M
852 M
1512 M
4013 M
TEMPERATURE CELSIUS
TEMPERATURE DEGREES C.
TEMPERATURE
PRESSURE DECIBARS
500
600
700
800
900
1000
1100
1200
1600.0
1800.0
2000.0
17
15
13
11
9
7
5
3
4.5
3.5
2.6
2.4
2.2
OCT 79
DEC
FEB 80
APR
JUN
AUG
OCT
DEC

Figure 23

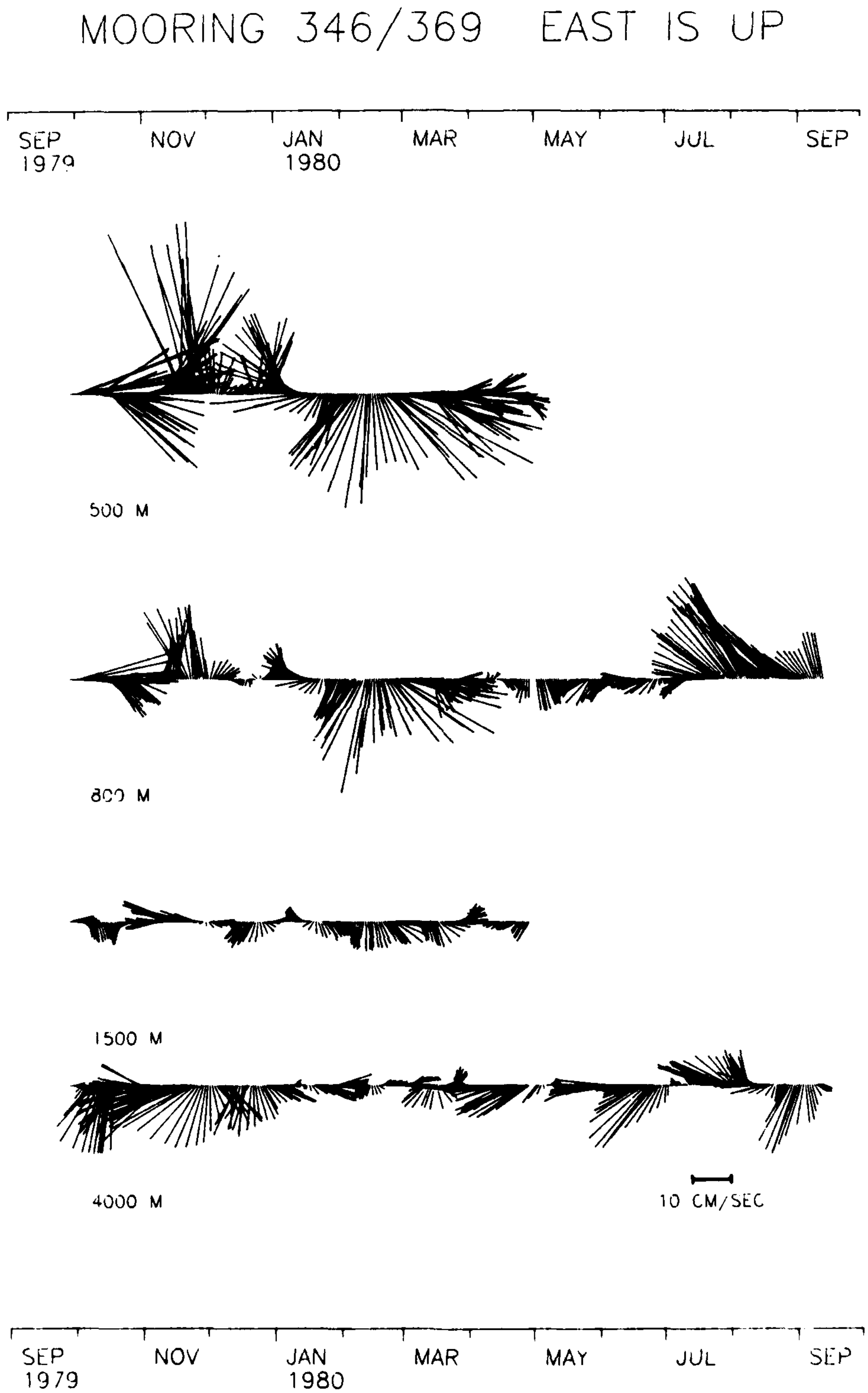

MOORING 346/369 EAST IS UP
SEP 1979
NOV
JAN 1980
MAR
MAY
JUL
SEP
500 M
800 M
1500 M
4000 M
10 CM/SEC
SEP 1979
NOV
JAN 1980
MAR
MAY
JUL
SEP

Figure 24

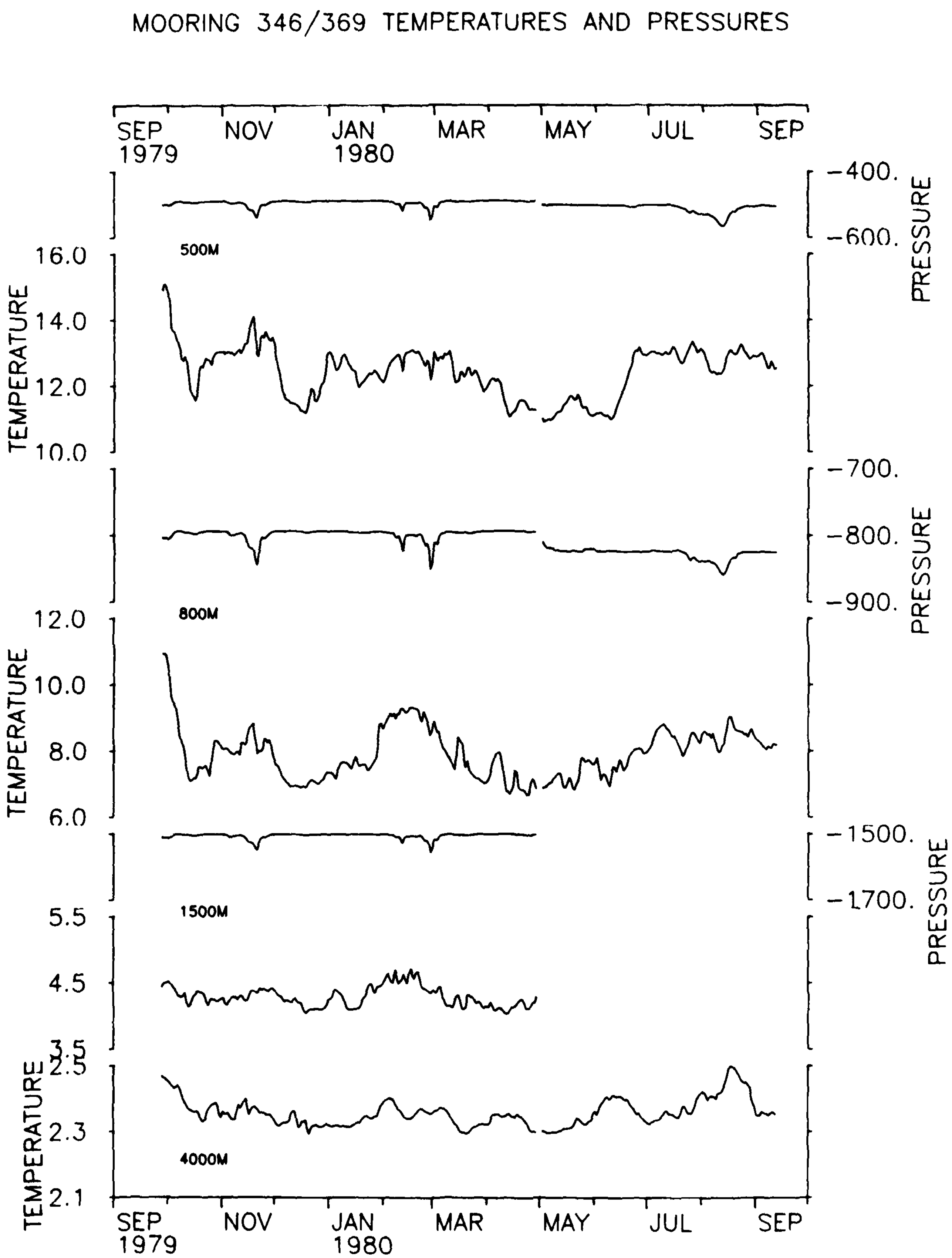

MOORING 346/369 TEMPERATURES AND PRESSURES
SEP 1979
NOV
JAN 1980
MAR
MAY
JUL
SEP
-400.
-600.
PRESSURE
500M
16.0
14.0
12.0
10.0
TEMPERATURE
-700.
-800.
-900.
PRESSURE
800M
12.0
10.0
8.0
6.0
TEMPERATURE
-1500.
-1700.
PRESSURE
1500M
5.5
4.5
3.5
2.5
2.3
2.1
4000M
TEMPERATURE
SEP 1979
NOV
JAN 1980
MAR
MAY
JUL
SEP

Figure 25

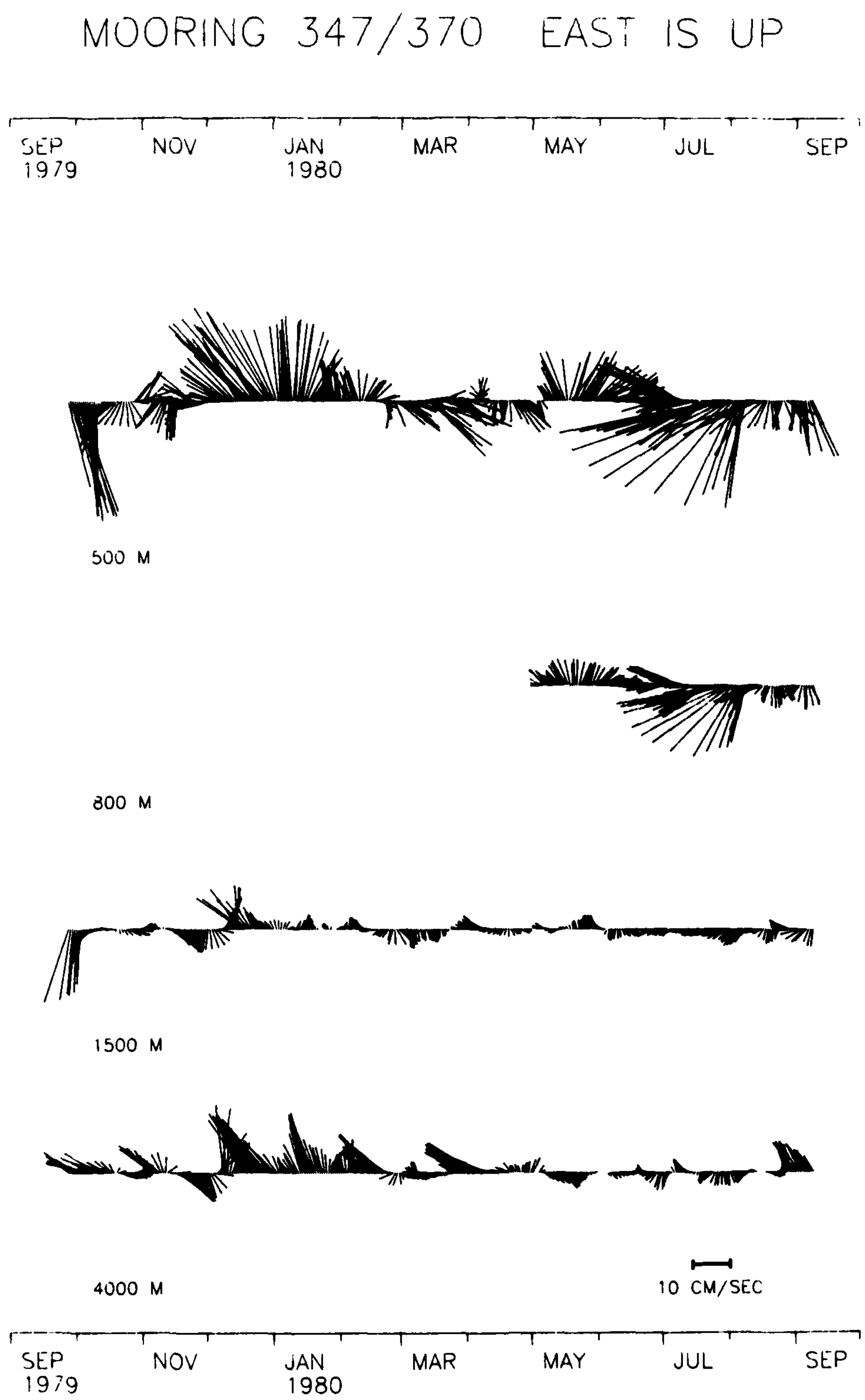

MOORING 347/370 EAST IS UP
SEP 1979
NOV
JAN 1980
MAR
MAY
JUL
SEP
500 M
800 M
1500 M
4000 M
10 CM/SEC
SEP 1979
NOV
JAN 1980
MAR
MAY
JUL
SEP

Figure 26

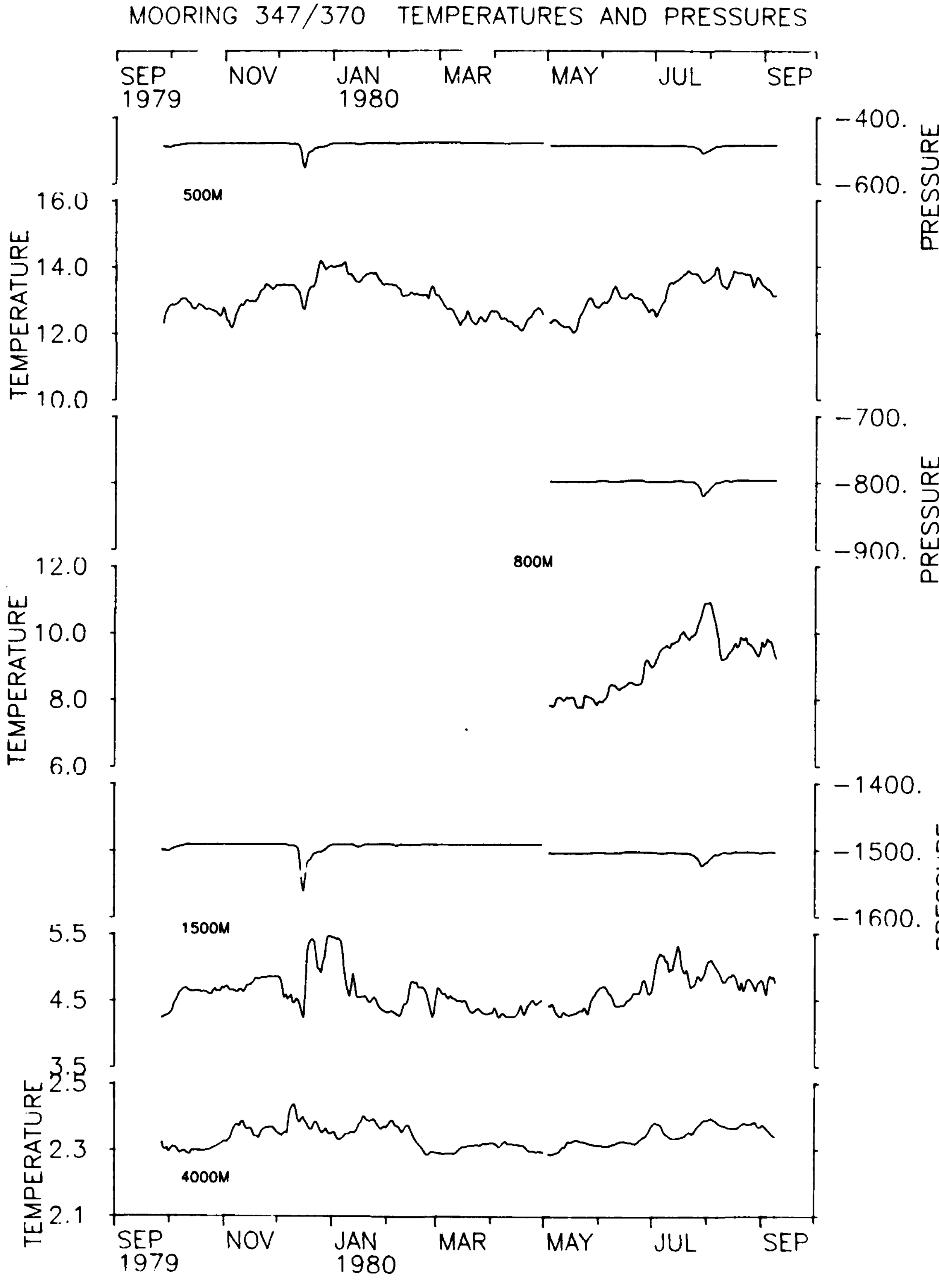

MOORING 347/370 TEMPERATURES AND PRESSURES
SEP 1979
NOV
JAN 1980
MAR
MAY
JUL
SEP
-400.
-600.
PRESSURE
500M
16.0
14.0
12.0
10.0
TEMPERATURE
-700.
-800.
-900.
PRESSURE
800M
12.0
10.0
8.0
6.0
TEMPERATURE
-1400.
-1500.
-1600.
PRESSURE
1500M
5.5
4.5
3.5
2.5
2.3
2.1
4000M
TEMPERATURE

Figure 27

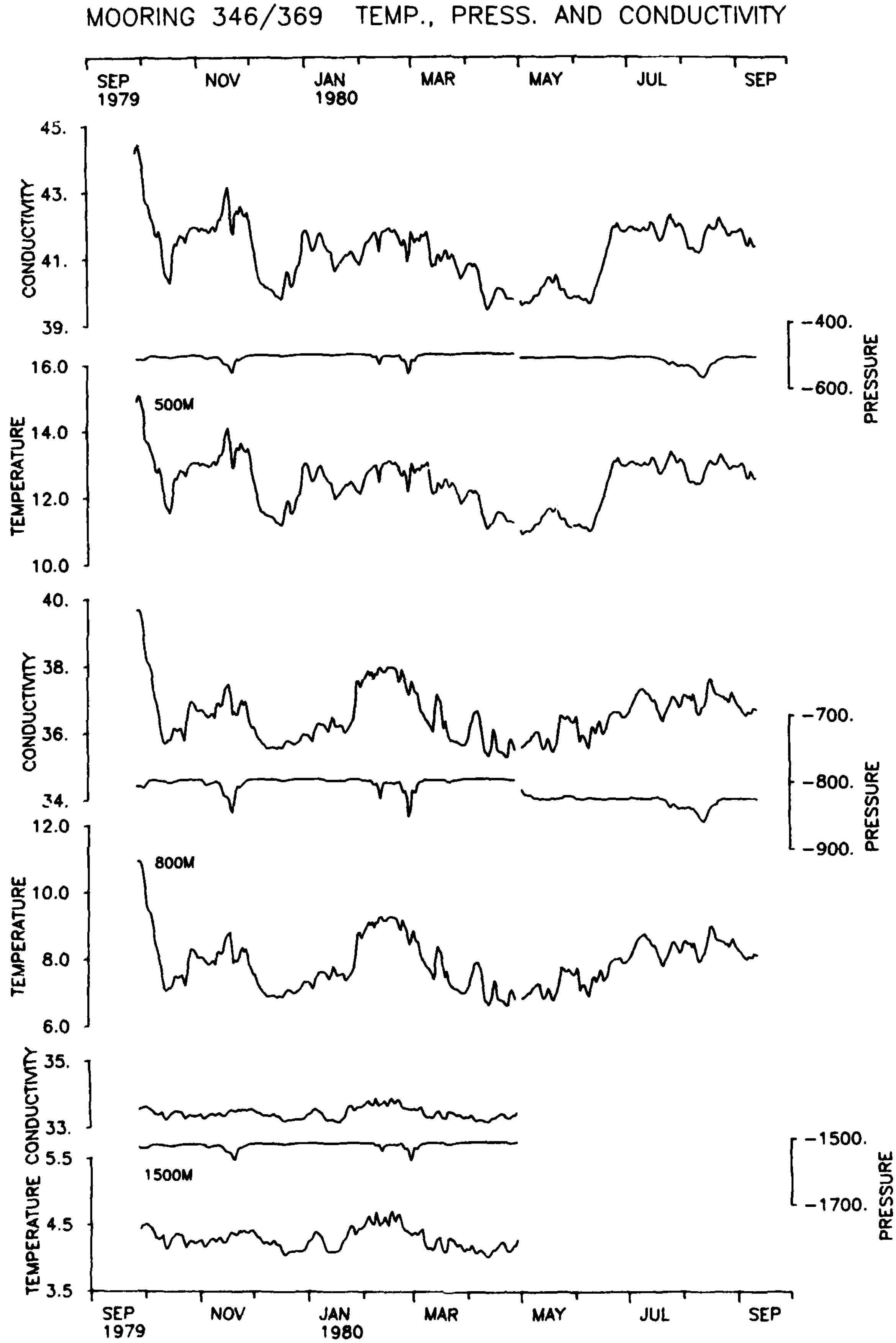

MOORING 346/369 TEMP., PRESS. AND CONDUCTIVITY
SEP 1979
NOV
JAN 1980
MAR
MAY
JUL
SEP
CONDUCTIVITY
45.
43.
41.
39.
TEMPERATURE
16.0
14.0
12.0
10.0
500M
PRESSURE
-400.
-600.
CONDUCTIVITY
40.
38.
36.
34.
PRESSURE
-700.
-800.
-900.
TEMPERATURE
12.0
10.0
8.0
6.0
800M
CONDUCTIVITY
35.
33.
TEMPERATURE
5.5
4.5
3.5
1500M
PRESSURE
-1500.
-1700.

Figure 28

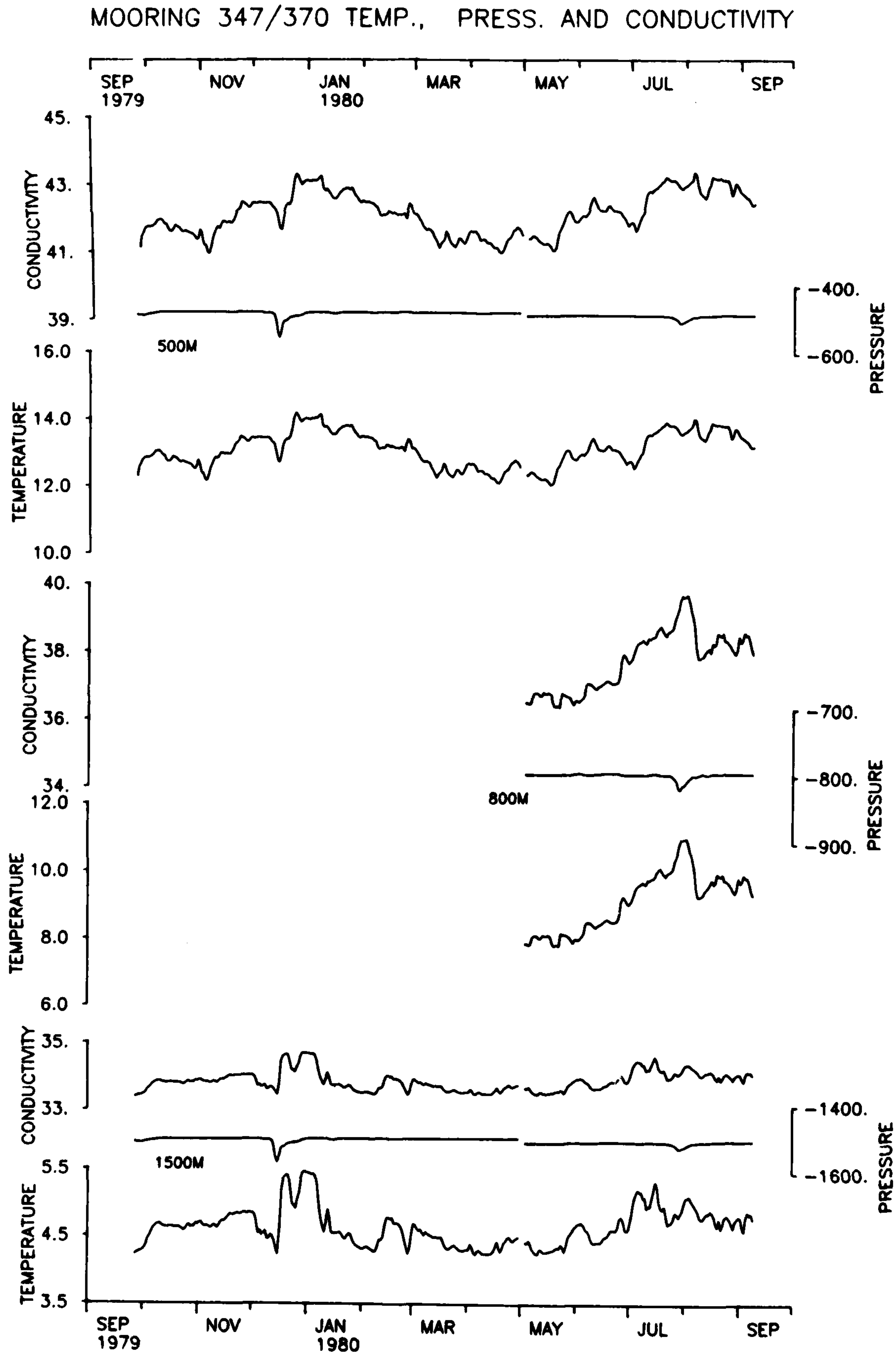

MOORING 347/370 TEMP., PRESS. AND CONDUCTIVITY
SEP 1979
NOV
JAN 1980
MAR
MAY
JUL
SEP
CONDUCTIVITY
45.
43.
41.
39.
500M
-400.
-600.
PRESSURE
TEMPERATURE
16.0
14.0
12.0
10.0
CONDUCTIVITY
40.
38.
36.
34.
800M
-700.
-800.
-900.
PRESSURE
TEMPERATURE
12.0
10.0
8.0
6.0
CONDUCTIVITY
35.
33.
1500M
-1400.
-1600.
PRESSURE
TEMPERATURE
5.5
4.5
3.5
SEP 1979
NOV
JAN 1980
MAR
MAY
JUL
SEP

Figure 29

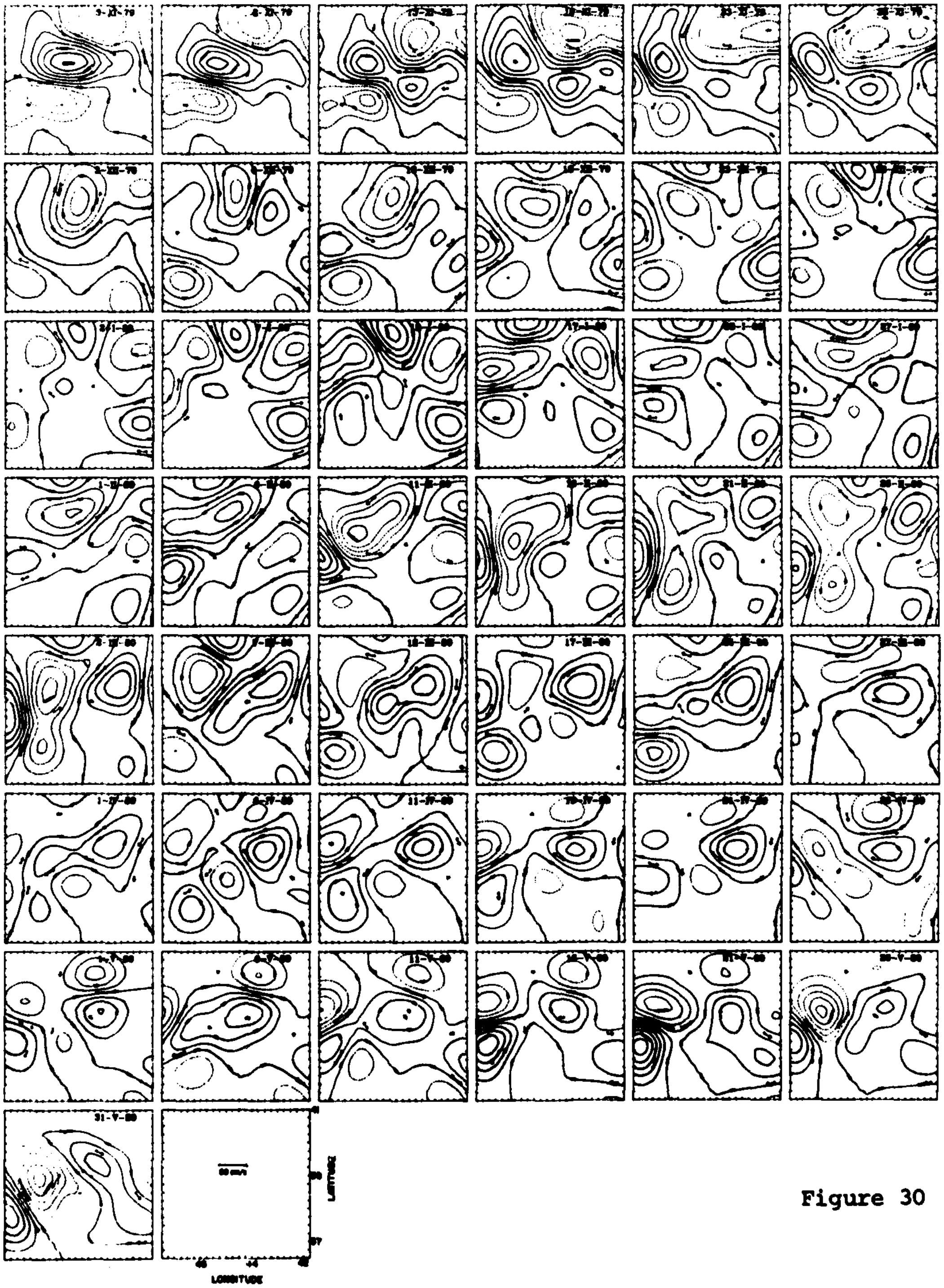


Figure 30

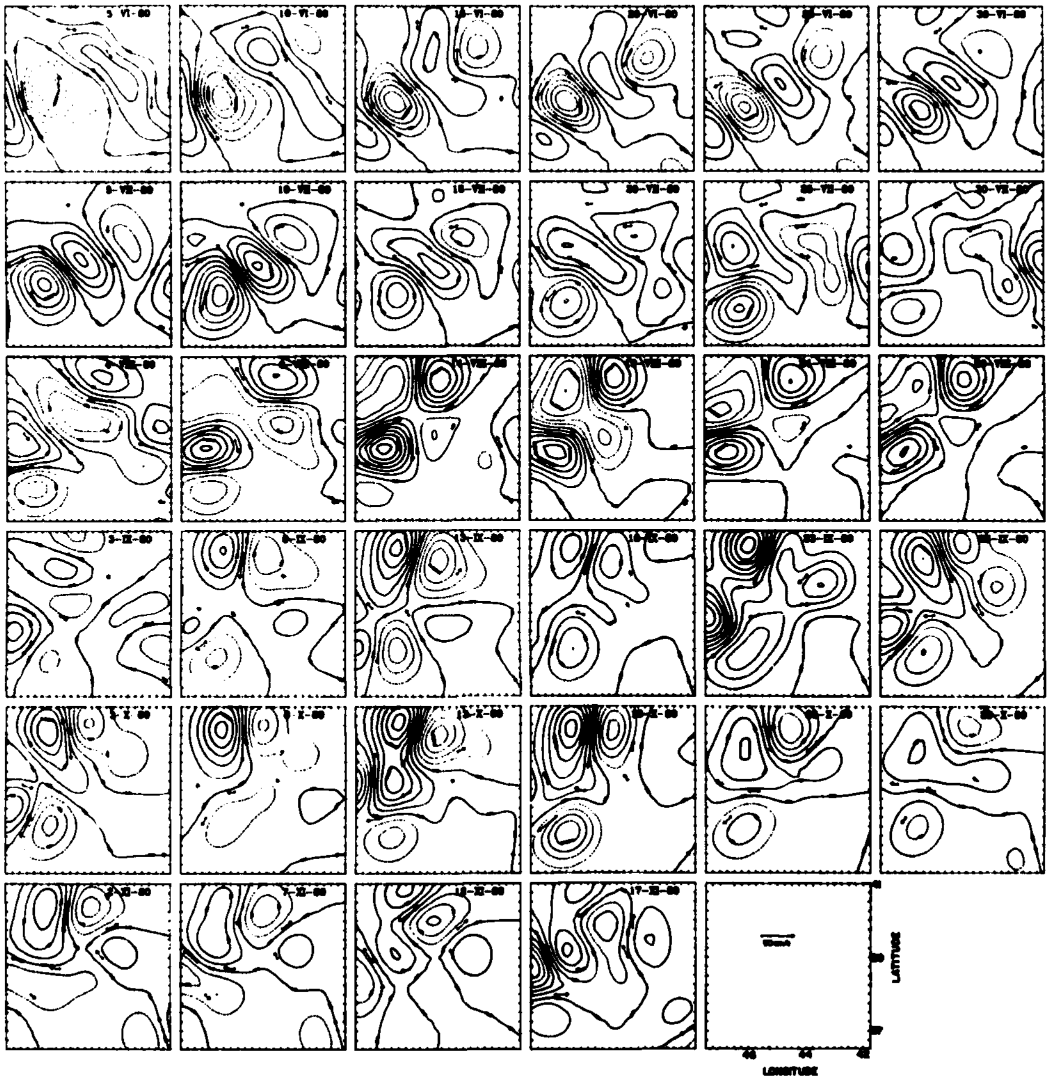


Figure 30: Stream function plots of current vectors, cyclonic and anti-cyclonic eddies. Every fifth day is plotted at the 500 meter level. Each row represents one month. Contour interval is 4000 m^2/s.

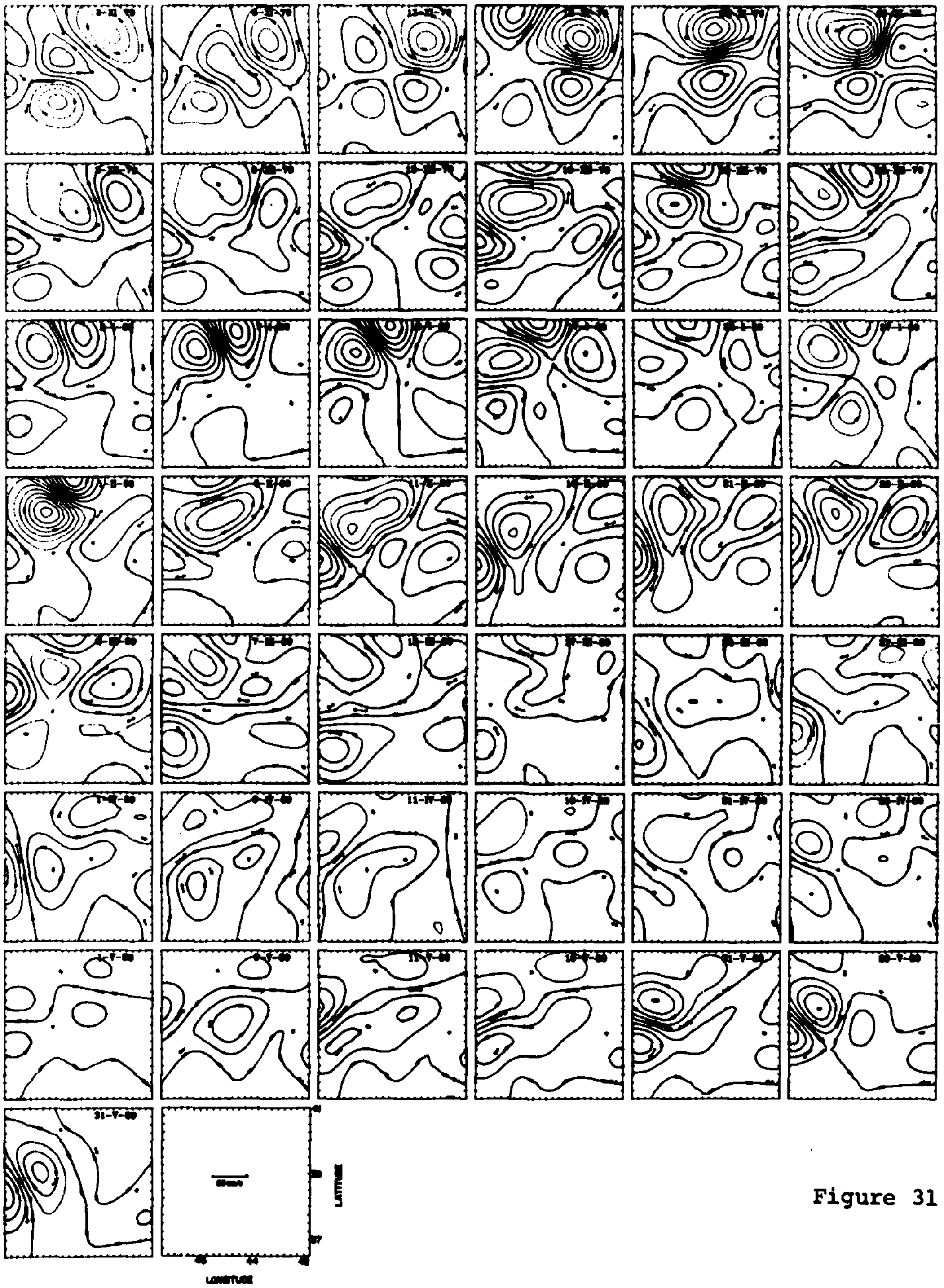


Figure 31

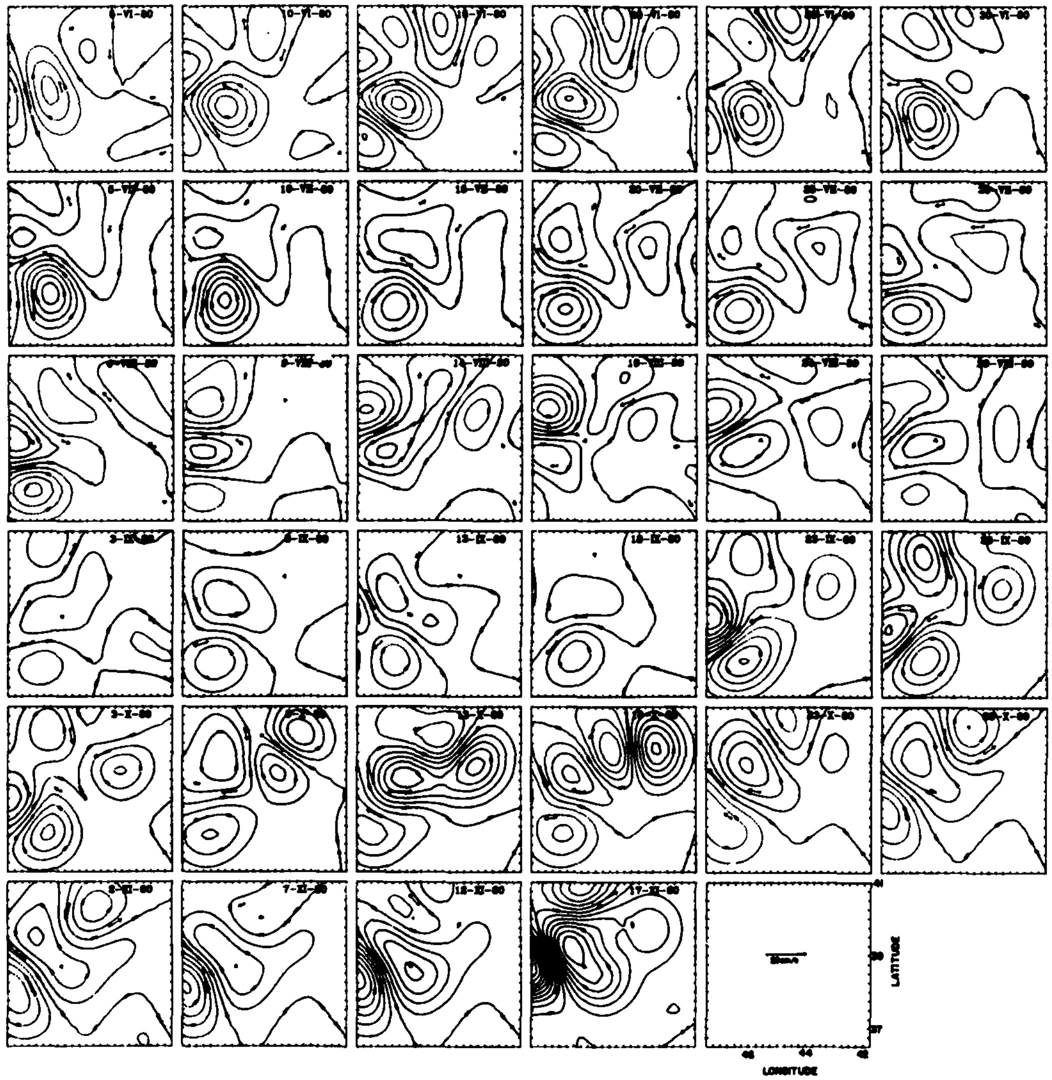


Figure 31: Stream function plots of current vectors, cyclonic and anti-cyclonic eddies. Every fifth day is plotted at the 1500 meter level. Each row represents one month. Contour interval is 2000 m^2/s.

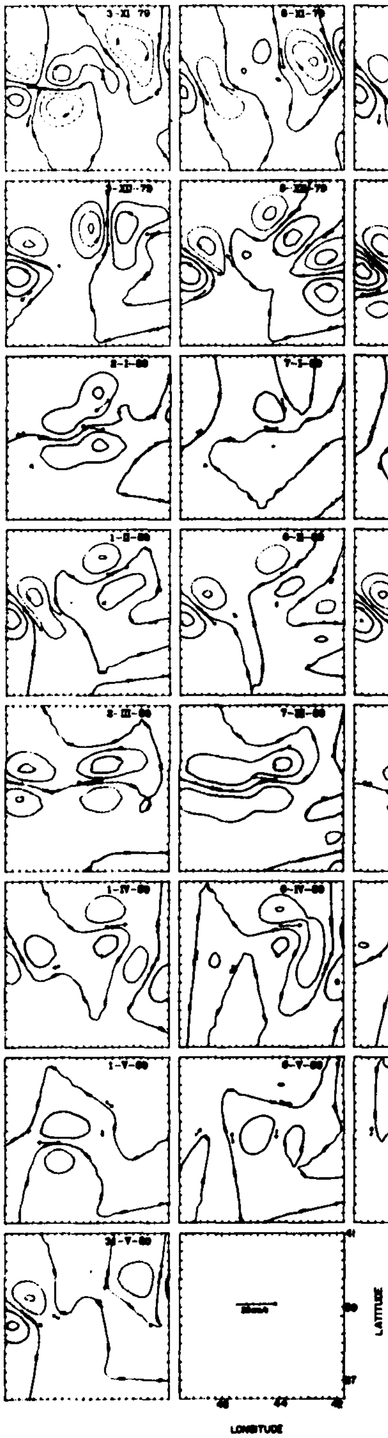


Figure 32

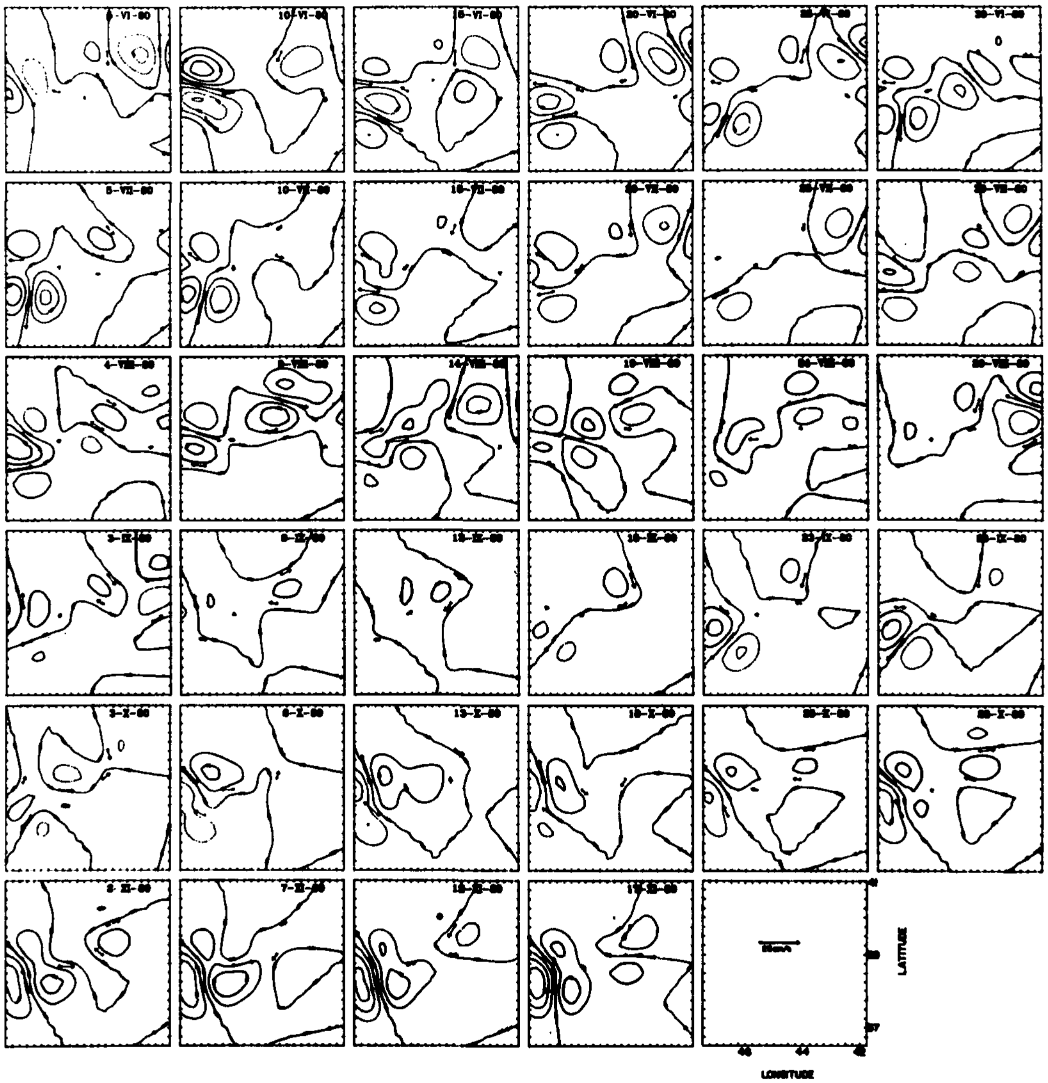


Figure 32: Stream function plots of current vectors, cyclonic and anti-cyclonic eddies. Every fifth day is plotted at the 4000 meter level. Each row represents one month. Contour interval is 2000 m^2/s.

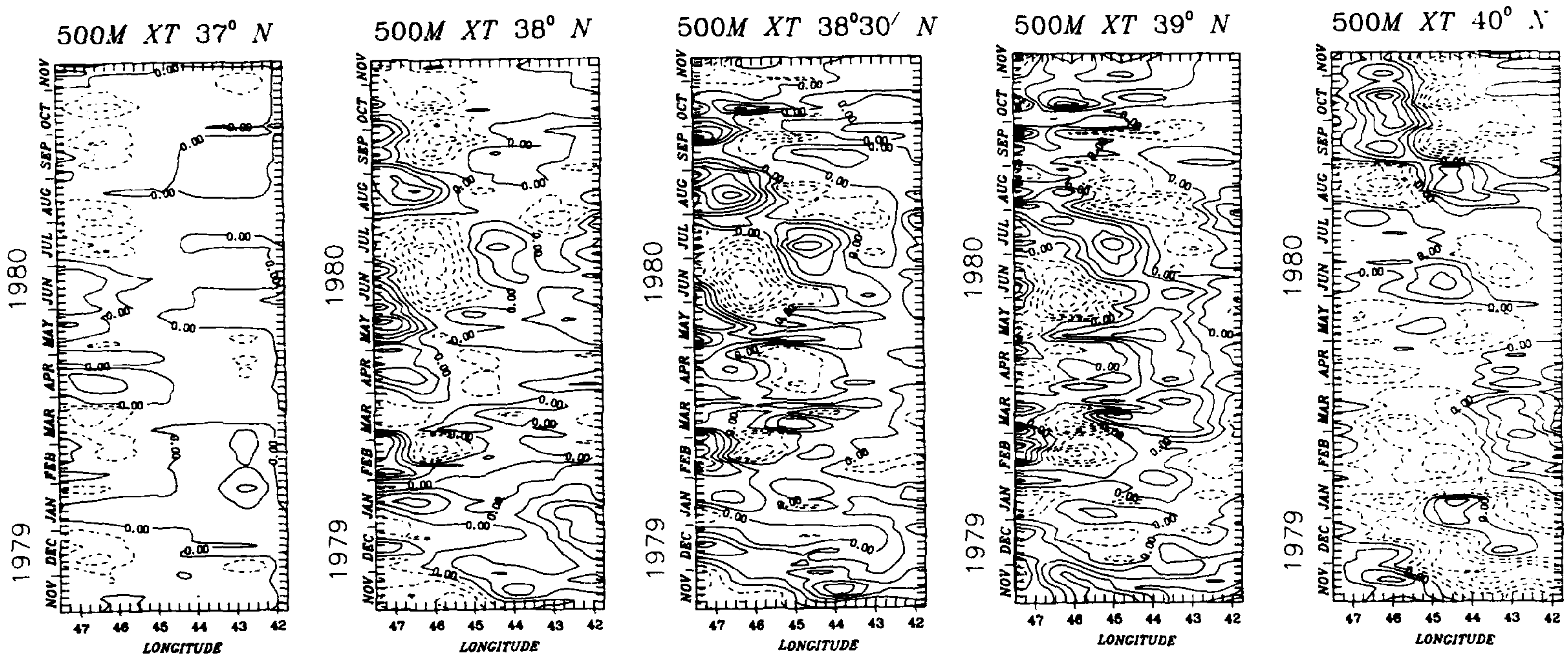


Figure 33: Time longitude of phase propagation diagrams (XT PLOTS) for 500 meter level. Longitudes 42°W through 47°W recorded every fifth day throughout the year at a fixed latitude. The contour interval is 4000 m^2/s.

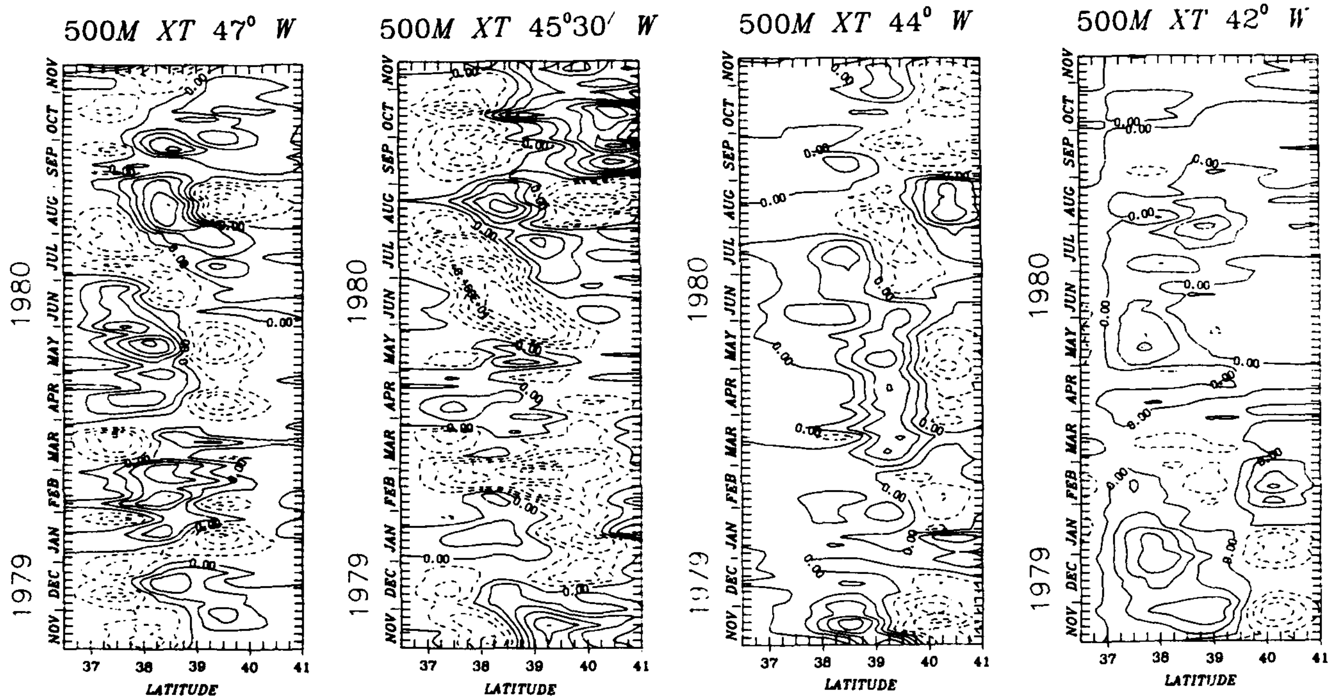


Figure 34: Time latitude of phase propagation diagrams (XT PLOTS) for 500 meter level. Latitudes 37°N through 41°N recorded every fifth day throughout the year at a fixed longitude. The contour interval is 4000 m^2/s.

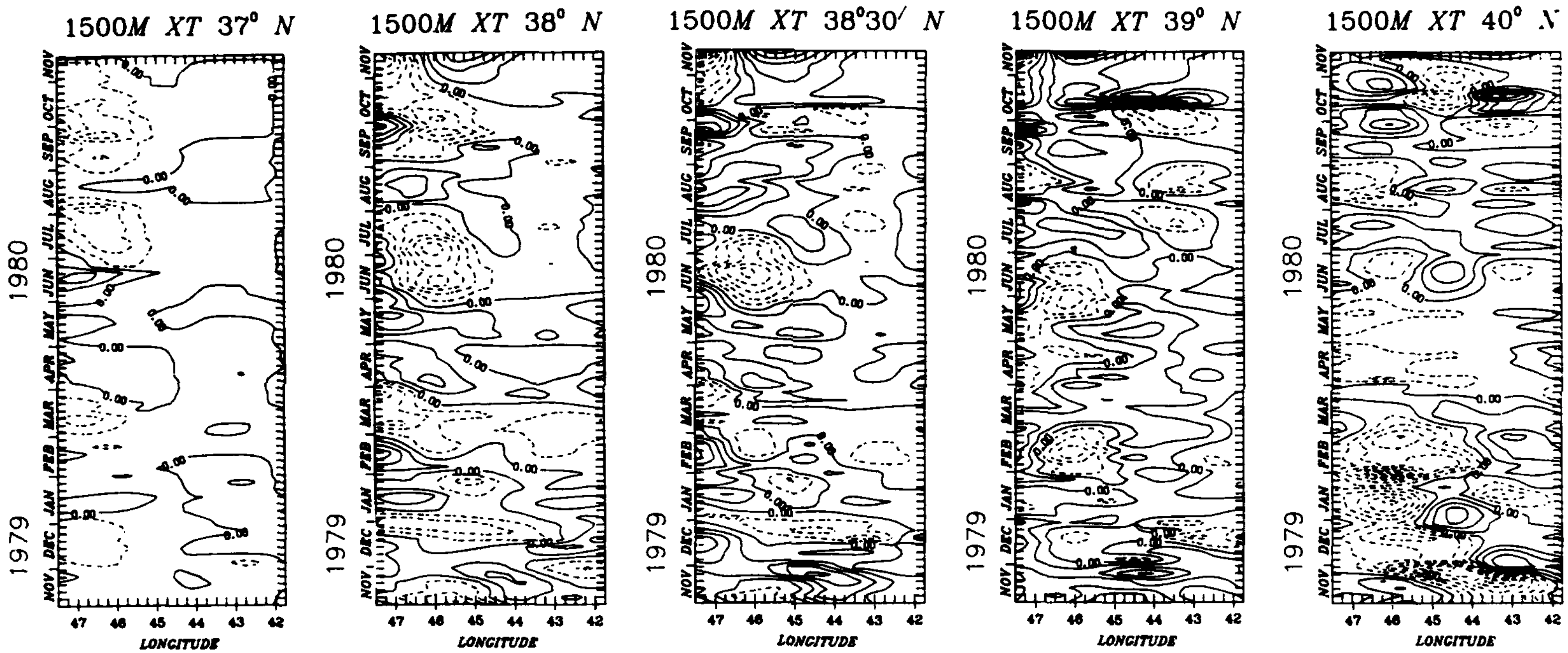


Figure 35: Time longitude of phase propagation diagrams (XT PLOTS) for 1500 meter level. Longitudes 42°W through 47°W recorded every fifth day throughout the year at a fixed latitude. The contour interval is 2000 m^2/s.

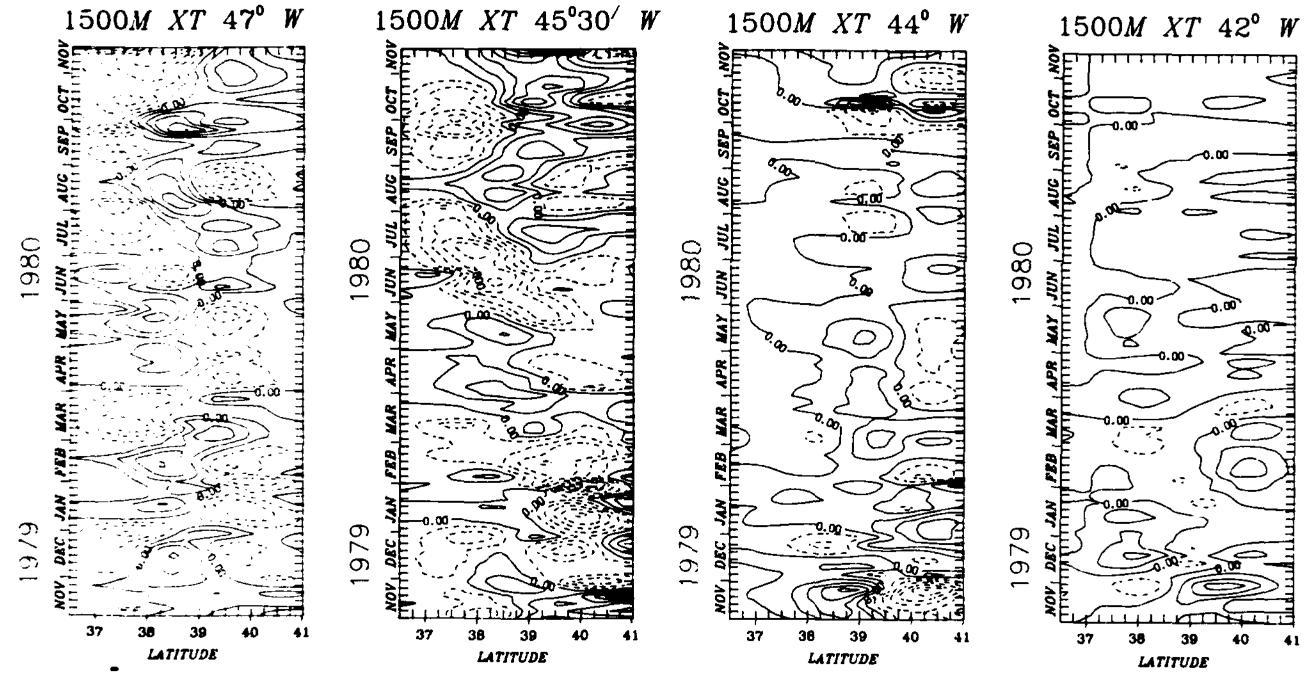


Figure 36: Time latitude of phase propagation diagrams (XT PLOTS) for 1500 meter level. Latitudes 37°N through 41°N recorded every fifth day throughout the year at a fixed longitude. The contour interval is 2000 m^2/s.

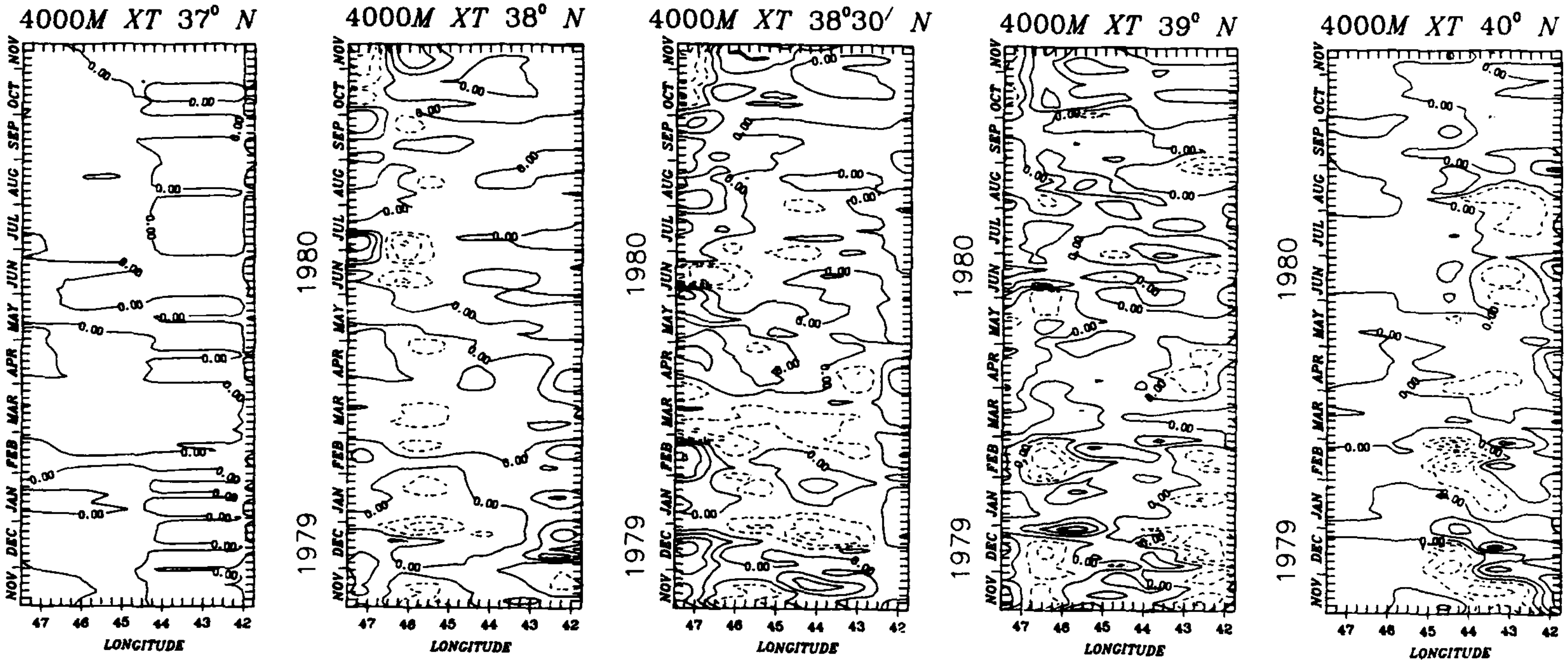


Figure 37: Time longitude of phase propagation diagrams (XT PLOTS) for 4000 meter level. Longitudes 42°W through 47°W recorded every fifth day throughout the year at a fixed latitude. The contour interval is 2000 m^2/s.

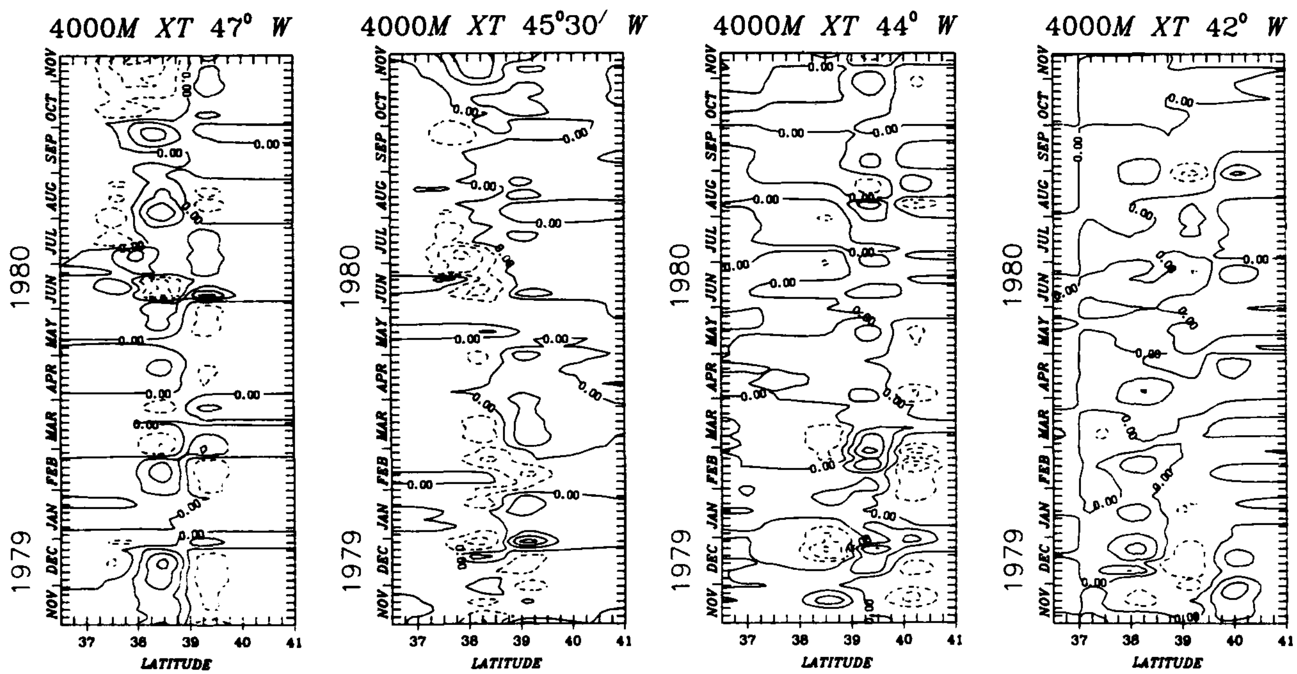


Figure 38: Time latitude of phase propagation diagrams (XT PLOTS) for 4000 meter level. Latitudes 37°N through 41°N recorded every fifth day throughout the year at a fixed longitude. The contour interval is 2000 m^2/s.

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Figure 29 1-F-12

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